BACTERIOLOGICAL PROFILE OF SURGICAL SITE INFECTION AND ANTIBIOTIC SUSCEPTIBILITY PATTERN IN TERTIARY CARE HOSPITAL.

Dissertation submitted in

Partial fulfillment of the Regulations required for the award of

M.D. DEGREE

In

MICROBIOLOGY– BRANCH IV

The Tamil Nadu

DR. M.G.R. MEDICAL UNIVERSITY

Chennai

APRIL 2015.

CERTIFICATE

This is to certify that the enclosed work **"BACTERIOLOGICAL PROFILE OF SURGICAL SITE INFECTION AND ANTIBIOTIC SUSCEPTIBILITY PATTERN IN TERTIARY CARE HOSPITAL"** submitted by Dr. DB.Shanthi to the The Tamilnadu Dr. MGR Medical University is based on bonafide cases studied and analysed by the candidate in the Department of Microbiology, Coimbatore Medical College Hospital during the period from August 2013 to July 2014 under the guidance and supervision of Dr. N.Mythily, M.D, Associate Professor in the Department of Microbiology and the conclusion reached in this study are her own.

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DECLARATION

I, **Dr. DB.Shanthi** solemnly declare that the dissertation entitled **"BACTERIOLOGICAL PROFILE OF SURGICAL SITE INFECTION AND ANTIBIOTIC SUSCEPTIBILITY PATTERN IN TERTIARY CARE HOSPITAL**" was done by me at Coimbatore Medical College Hospital, during the period from August 2013 to July 2014 under the guidance and supervision of **Dr. N Mythily, M.D,** Associate Professor, Department of Microbiology, Coimbatore Medical College, Coimbatore.

This dissertation is submitted to The Tamilnadu Dr. MGR Medical University towards the partial fulfilment of the requirement for the award of M.D. Degree (Branch – IV) in Microbiology.

I have not submitted this dissertation on my previous occasion to any University for the award of any degree.

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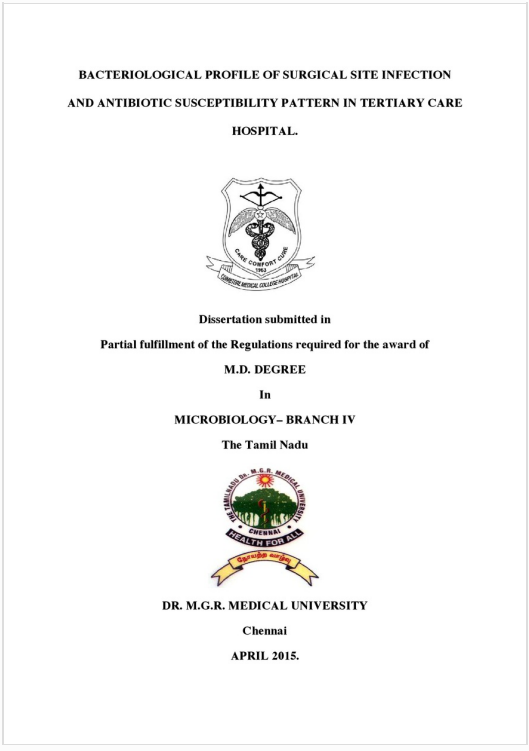

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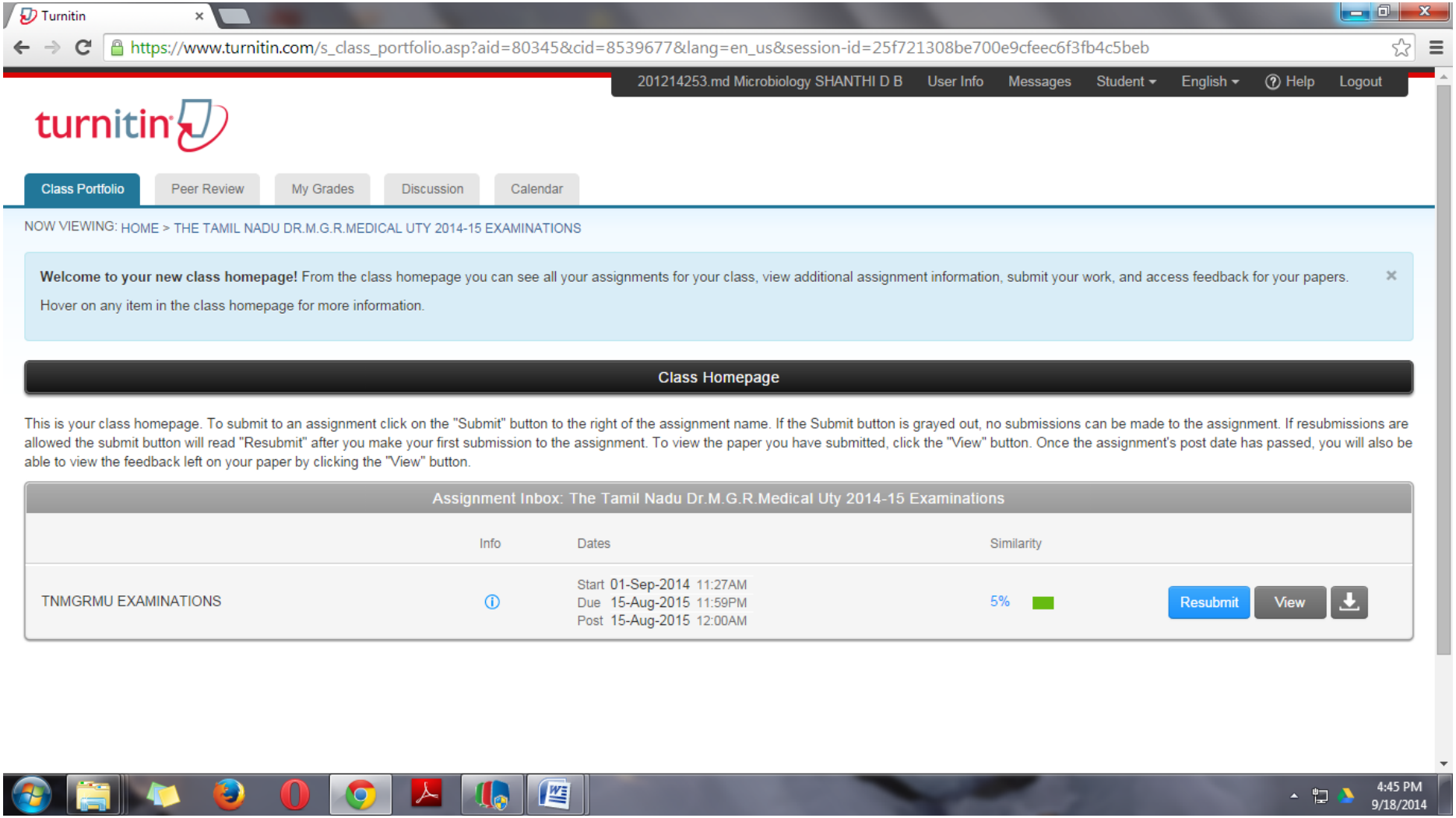
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CONTENTS

BACTERIOLOGICAL PROFILE OF SURGICAL SITE INFECTION AND ANTIBIOTIC SUSCEPTIBILITY PATTERN IN TERTIARY CARE HOSPITAL.

ABSTRACT

INTRODUCTION:

Surgical site infections are one of the most common nosocomial infections accounting for 38% of all infections in post surgical patients. The aim is to find out the incidence rate of surgical site infection in patients undergoing surgery in the departments of Surgery, Orthopedics,Obstetrics and Gynaecology and its antibiotic susceptibility pattern

MATERIALS AND METHODS:

Under sterile aseptic precautions, Pus exudate was collected using two sterile cotton swabs for aerobic culture and for anaerobic culture pus was aspirated in a sterile syringe and inoculated onto Blood agar and Macconkey agar, Nutrient agar and Robertson cooked meat media. The samples were processed as follows, Direct microscopic examination of Gram stained smear, preliminary identification by colony morphology,Biochemical test for characterization of species and Antibiotic sensitivity testing.

RESULTS:

Out of 220 cases,137 were male patients and 83 were female patients with infection rate more in Male.Clean wound were 20 ,Clean contaminated wound were 71,Contaminated wound were 110 and Dirty wound were 19 ,with infection

rate more in Contaminated wound. Elective surgeries were 98 and Emergency surgeries were 122 with infection rate more in Emergency surgeries .Culture positive were 153 and Culture negative were 67. In the culture positive cases, aerobic were 146 and anaerobic were 7. Among the aerobic isolates Staphylococcus was the most common Gram positive organisms isolated and klebsiella pneumoniae was the most common Gram negative organism isolated.

CONCLUSION:

Knowledge about Surgical site infection will help surgeon in diagnosis and treatment, early detection and intervention is a prerequisite in surgical patients.Although surgical wound infections cannot be completely eliminated, a reduction in infection rate to a minimum level could have significant benefits, by reducing burden to patients and their families. Intervention aimed at reducing Surgical site infection would provide cost savings and improve the efficiency of health care system.

INTRODUCTION

Surgical site infections are infections, which occurs after any surgical procedure along the surgical tract. In our population they are the common nosocomial infections. They occur at any level (incisional or deep) , accounting for 38% of all infections in post surgical patients.[1]

In the 2nd half of **19th century, IGNAZ PHILIP SEMMELWEIS** discovered that, effective **hand washing** using antiseptics has prevented puerperal sepsis in postnatal mothers. **LISTERS** introduction of **antiseptics** in surgery using carbolic acid greatly reduced infections in surgical patients.[2]

PASTEUR, HOLMES, and KOCHER worked in the field of infectious diseases. **HALSTED**, proved that aseptic and antiseptic techniques were effective in preventing post operative infections.[3]

Discovery of **PENICILLIN** by **ALEXANDER FLEMING** in 1928 acts as a powerful weapon in treating wound infections. But recent wide spread and indiscriminate use of antibiotics have made it difficult to prevent and control such infections. Increasing number of serious infections were due to long duration complicated surgeries, increase in older age group patients with chronic

infections, usage of implants, immunosuppresants drug usage in organ transplant surgeries and newer diagnostic technique results in increased exposure to microorganisms.

It is the surgeons responsibility to deal with such infections, for which an appropriate knowledge of aseptic and antiseptic techniques is necessary. Prophylactic and therapeautic antibiotics has to be used properly. Adapting good techniques during surgery plays a significant role in reducing such infections

Definition:[4]

Infections occurring at surgical site within one month if no implant used or within 1year if implant used in surgery. They are classified as

a) Incisional infections → superficial
                        → deep

b) Organ / space infections

Incisional infections:

- Commonest accounting for 60-80% of surgical site infections.
- Involves skin and subcutaneous tissue.
- Has better prognosis than organ/space infections.

- Organ/space infections:
- Less common.
- Involves related organ or space
- Mortality rate was 93% in surgical site infections involving organ/space .

Classification of surgical site infections:

According to degree of contamination, wounds are classified as[5]

1) Clean wound
2) Clean contaminated wound
3) Contaminated wound
4) Dirty wound

Accepted range for various wounds were clean (1-5%), clean contaminated (3-11%), contaminated (10-17%), dirty (27%).

Multiple risk factors have been identified which comes under four major determinants of surgical site infections namely

a.Bacterial factors:

Depends upon the bacterial load and its virulence factors in the surgical site. The virulence factors contributing to pathogenicity by inhibiting phagocytosis are slimelayer of coagulase negative Staphylococci and capsule of Klebsiella. Surface components such

as endotoxins or lipopolysaccharides of gram negative bacteria and exotoxins of certain gram positive bacteria establish infections within 1-5 days.

Bacterial load (or) Inoculum is an inevitable factor in causing infections and the conditions associated with bacterial load are

- In traumatic wounds with >10^5 organisms, infections are frequent where as those wounds with<10^5 organisms are usually not infected.
- Length of the preoperative stay.
- Certain pre operative procedures such as shaving are associated with increased bacterial load and surgical site infections.
- Remote infections at the time of surgery, duration of procedure etc.

b. Local wound factors related to the

- Invasiveness of an operation.
- Skill of the surgeon.
- Break in barrier defence mechanism (skin, mucosa of gastro intestinal tract).

- Adequate indications for use of sutures, drains and foreign bodies such as implants.

c. Patient related factors

Play a very important role in surgical site infections. They are;

- Age,immunosuppression,steroid,malignancy,smoking,diabetes,malnutrion, etc are the major factors causing surgical site infections.
- Maintaining normothermia.
- Improving oxygen tension and WBC function in surgical area.
- Control of glucose level in the perioperative period can prevent surgical site infections.

d. Perioperative antimicrobial prophylaxis:

The interaction between the prophylactically administered antibiotics and the inoculated bacteria during surgery is one other most important determinant in development of surgical site infections .The principle of antibiotic prophylaxis is based on the belief that, antibiotics augment the natural host defence mechanisms, thereby removing the bacterial inoculum in the wound. so adequate antbiotic level should be maintained above minimum inhibitory

concentration throughout the surgical procedure. Hence knowledge about pharmacokinetics of various antibiotics used in perioperative prophylaxis is important in preventing surgical site infections.[6]

Microorganisms causing surgical site infections were from external environment or from endogenous microflora. Exogenous microorganisms include those from water, air of operating room, equipment used in surgery or from theatre staff.

Study conducted by CDC have shown that the common pathogen causing infection at surgical site were Staphylococcus aureus followed by Coagulase negative staphylococci, Escherichia coli and Enterococci . Escherichia coli remain the most common cause of surgical site infections in clean contaminated wound and in contaminated procedures. Some emerging infections are more common in recent years.

Understanding the microbiology of surgical site infections is very important in treating the patients and taking prophylactic measures. The most important measure to decrease the bacterial load in surgical site include adapting aseptic precautions , following antiseptic methods and using antimicrobial prophylaxis.

Antimicrobial prophylaxis used systemically acts as a powerful preventive measure in controlling surgical site infections. But indiscriminate use of antibiotics, has lead to the emergence of antibiotic resistant strains and increase the incidence of surgical site infections.

As complications are more with infection at surgical site, it is imperative to start the treatment early. An extensive study of the organisms causing surgical site infections and their antibiotic susceptibility will be very useful in reducing the incidence of surgical site infections. So this study is being undertaken in the departments of Orthopaedics, Surgery and Obstetrics and gynaecology, to find out the bacteriological profile of surgical site infections and their respective antibiotic susceptibility pattern . The optimal choice, frequency and duration of antibiotics forms the mainstay in the prophylaxis and treatment of surgical site infections

AIMS & OBJECTIVES

AIMS AND OBJECTIVES

Surgical site infections are an important risk factor associated with any surgical procedure, causing significant burden to patients in terms of morbidity, mortality and increased health care cost. In order to reduce the incidence and prevalence of post operative infections, this study is conducted to

- Find out the bacteriological profile of surgical site infections thereby identifying the predominant organisms causing surgical site infections.
- Determine the antibiotic sensitivity and resistance pattern of the isolates.
- Assess the risk factors involved in surgical site infections.
- Evaluate the incidence rate of surgical site infections in the patients undergoing surgery in the departments of Surgery, Orthopaedics and Obstetrics and Gynaecology.
- Compare the prevalence of surgical site infections and bacteriological profile in elective versus emergency cases.
- Compare the bacteriological profile in different wound classes (ie) clean, clean contaminated, contaminated and dirty.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

HISTORY

The first civilians were ancient Egyptians , who have trained clinicians to treat physical ailments. **Ebers Papyrus (1534 BC) and Edwin Smith Papyrus** (1600 BC) provided detailed information on management of infection, including wound infection management with the application of grease to assist healing.[7]

The earliest available advice on hygiene and hospital construction is available in the **'CHARAKA SAMHITA'. SUSHRUTHA,** The father of Indian surgery, who practiced surgery in the 6th century BC, wrote extensively on wounds, its process of repair and management. He greatly emphasized that, knowledge about management of wounds is very important for the practice of good surgery.8

HIPPOCRATES, father of medicine, who practised medicine and surgery at the same time as Sushruta, described the method of management of wounds in great detail. Vinegar was used in wound dressing to hasten the healing process.[9]

Before **PASTEUR'S** revolutionary studies in bacteriology and Lister's application of them to wounds, most of the wounds were infected and the mortality rate was around 70-90%. As

majority of wounds were due to trauma and occurred during war, stimulus for solutions to the problem of infections came during the war times.[9]

AMBROSE PARE (1500-1590), a French army surgeon, treated wounds with scalding oil or red hot cautery. He is famous for his quote –'I dressed the wound and god healed it'.[9]

JOHN HUNTER (1758-1793), described wound healing by first intention in all clean cut wounds and healing by second intention in all delayed case of healing . He used adhesive plaster for approximating the wound edges thereby decreasing the chance of suppuration.[10]

The introduction of anaesthesia by **Long** in 1842 and by **Mortan** in 1846, increased the scope of surgery by permitting operations on body cavities. This allowed surgeons to operate slowly and deliberately, so that death due to blood loss was decreased.

Infection still remained a great problem. Erysipelas, a necrotizing infection caused by Clostridium tetani and streptococcus continue to plague surgeon and physicians by causing more number of deaths in traumatic patients.

LOUIS PASTEUR'S contribution to the field of asepsis were his techniques of sterilization, development of steam sterilizer, hot air oven and autoclave.[11]

JOSEPH LISTER became aware of Louis Pasteur's germ theory and in 1860, he attempted to apply it to surgery. By late 1860 he was using carbolic acid to disinfect the wounds and the antiseptic principle or Listerian method emphasized treatment of wounds after operation, although many surgeons resisted initially they gradually adopted it. The development of Listerism and aseptic techniques revolutionized the treatment in which extremity was salvaged.

Even late in the 19th century aseptic surgery was not practiced. Surgeons washed hands only after surgery and not before the operation. **Ignaz semmelweis**, an Austrian gynaecologist, realized that surgical infection was transmissible and he noted an increased incidence of puerperal sepsis among postnatal women delivered by physicians who had attended autopsy. He showed that maternal mortality caused by puerperal sepsis could be reduced from 10% to 2% by the simple act of **hand washing** between cases especially when going from post mortem to delivery suite.[12]

In 1882, **Ernst Bergman** said, 'Today we wash our hands before an operation'.

Gloves were not routinely worn until the early part of 20th century **William Halstead** introduced **rubber gloves** for his scrub nurse Caroline Hampton because Hgcl used to sterilize instruments irritated her skin. Halsted's student Joseph Blood Good introduced use of gloves for the entire operating team.[13]

Sterilization of instrument first by chemical and then by steam came into practice in 1880's and 1890's. Wearing of caps , masks , gloves , gowns and hand washing were also introduced during the same period.

Concept of 'Magic Bullet' (Zauber Kugel) that could kill microbes but not their host first became a reality with the discovery of sulphonamide chemotheraphy in the mid twentieth century.

The introduction of antibiotics was a major step in the treatment of infections. Although **Alexander Fleming** in 1928 made a discovery that fungus Penicillium produced a substance that could destroy staphylococcus.

The active microbial substance was not used clinically until administration by Howard Foley in 1940 to treat a severe mixed infection with staphylococcus aureus and streptococci in Oxford. Penicillin was rapidly introduced in clinical practice followed by streptomycin in 1944 and other numerous antibiotics.

John Burke published his study about the timing of chemoprophylaxis in dermal wounds. During his study he observed that antibiotics given systemically were effective against staphylococcal strains, only if present within short period of incision. These data leads to universal agreement that adequate systemic antibiotics need to be present in the immediate pre incisional period to ensure maximum effectiveness. [14]

Unfortunately it is very difficult to control surgical site infections due to the emergence of antibiotic resistant strains and newer surgical techniques using implants and prosthetic materials and use of immunosuppressive drugs.

INCIDENCE

The global estimate of surgical site infection rate was around 0.5-15%. Various studies in India had shown that incidence rate of surgical site infection was 23-38%. This variation was due to the differences in clinical procedures, types of organisms, resistance pattern of the organisms, control measures and hospital environment.

Many studies had published the infection rates of different types of wounds ie, (Clean, Clean contaminated, Contaminated, Dirty) , But most studies refers to Cruse and Foord studies on infection rate in various types of wounds. , Infection rate before the use of prophylactic antibiotics was for clean wounds(1-2%) , for clean contaminated wounds(6-9%) , for contaminated wounds(13-20%), for dirty wounds (40%), and the infection rate was reduced after the use of prophylactic antibiotics.[15]

US National Nosocomial surveillance system reported that the infection rate in Clean wounds was (2.1%) and (3.3%) of clean contaminated wounds were found infected. For contaminated wounds infection rate was (6.4%) and for dirty wounds(7.1%).

Infection rates in different classes of wounds can vary according to the types of surgery performed and studies were conducted to find out the incidence in different classes of wound during varying periods of time.[16,18,]

The National Research Council (1964) conducted a study for a 2½year in 15,613 surgeries done in American university centers with the support of United States Public Health Service, designated the operative wounds as Clean, Clean contaminated, Contaminated and Dirty wounds. In the 11,690 clean elective operations, the average wound infection rate was 5.1 % and the overall incidence rate in all types of wounds was 7.4%.[17]

Cruse and Foord (1980) reported an incidence rate of 4.7% in a study of 62,939 operations and an incidence of 1.5% 7.7%, 15.2% and 40% in clean, clean contaminated, contaminated and dirty operations. It became apparent that the incidence of infection varied with the type of operation. They also compared the incidence of infection with risk factors such as, age, sex, type of operation, preoperative stay, wound drainage and predisposing factors such as Diabetes.[15]

Kumar raj and mittal studied a total of 698 cases out of which 50 developed clinical wound infection and 42 were bacteriologically positive giving overall infection rate of 7.1% and purulent infection rate of 6 % in the study published in January 1976.Of the clean cases developing wound infection whether given prophylactic antibiotic or not, the offending organism in almost 75% of the cases has been coagulase negative staphylococcus .No significant difference in the incidence of wound sepsis has been found in clean cases treated with or without prophylactic antibiotics. The predominance of Staphylococcus in the infected wound in clean cases and the frequency with which it has been found on culture from the articles in the operation theatre, surgical wards nose and throat swab indicates possible source of contamination in hospital environment.[19]

Mustafa Ajaz et al., in 2004 studied 150 patients of elective surgeries out of which 37 developed SSI with infection rate of11.3%.The microorganism cultured were Staphylococcus aureus 70.5% and Escherichia coli 29.5%.The postoperative microbiological culture were significantly positive in patients who had longer preoperative and postoperative stay in hospital.[20]

Sangrasi Khan Ahmed studied 460 patients, of which 60 patients developed post operative wound infection. The rate was 5.3% for clean and 12.4 %for clean contaminated wound. Surgical drain, low haemoglobin level, longer duration of operation are associated with increased incidence of wound infection.[21]

A study of Agarwal in post operative wound infections in 1972 revealed that, out of 263 cases studied, 53 cases developed surgical site infections with infection rate being 20% . He observed that, the longer the duration of surgery, more are the chances of infection which were also more common in summer due to increased sweating in patients and surgical teams . [22]

Sengupta et al., studied a total of 200 wounds, out of which 103 developed surgical site infections. He observed a high rate of sepsis of about 68% in low socioeconomic groups. Infections due to gram negative bacilli were more common and among these pseudomonas was the most common organism isolated.[23]

Agarwal studied 200 patients during their pre and postoperative stay in hospital from January 1980 –November 1980. Out of these 99 patients developed infection. The surgical site infection rate was more in elderly patients , emergency surgeries, higher order of surgeries, contaminated cases and long duration of

hospital stay. Escherichia coli was the most common organism isolated followed by Staphylococcus aureus, Enterobacter aerogenes, Pseudomonas aeruginosa and Proteus.[22]

During the 10 year surveillance of wound infection (January 1977- January1987) Olson Mary, James, found that out of 40915 cases studied, 25919 were clean cases with infection rate of 2.5% and 10775 cases were clean contaminated with infection rate of 2.8%. The most frequent isolate in clean cases were Staphylococcus aureus followed by Enterococcus and Pseudomonas and most organisms in clean contaminated cases were Escherichia coli followed by Pseudomonas and Staphylococcus aureus.[23]

Garibaldi Richard et al., studied 1852 cases from January 1982 to January 1986 and their studies revealed that out of 1852 cases 788 were clean cases with SSI rate of 2.6% and 1009 cases were clean contaminated with SSI rate of 8%. Staphylococcus aureus was recovered from 87 wound infection with culture positivity, Enterococcus isolated in 17% of wound infection, Escherichia coli isolated from 15% cases, Enterobacter aerogenes (13%) and Pseudomonas aeruginosa (8%).

They identified four independent variables that are highly associated with SSIs and they are[24]

- Classes of wounds
- American society of anaesthesiologist score
- Duration of surgery more than 75 th percentile
- Positive culture

Anvikar conducted study on surgical site infections for one year period from September 1997- August 1998. Of the 3280 operated cases studied, the overall infection rate was 6.09% . It was found to be 4.04% in clean cases and 10.06% in clean contaminated cases.[25]

Infection rate was more in clean contaminated cases and also more in cases with longer pre-operative hospital stay, increased duration of surgery and emergency cases. Gram negative bacilli were more common and in that klebsiella pneumoniae was the commonest with incidence rate of 26.8%.

Lilani SP, studied 190 cases of surgical wounds between 2001 and 2002 and found 17 cases to be infected, with the overall infection rate of 8.95%. Infection rate for clean surgeries was 3.03% and in clean-contaminated surgeries infection rate was 22.41%.[26]

Umesh SK, in 2005 analysed 114 cases undergoing various surgeries and found 35 cases to be infected. The overall SSI rate was 30.07%. The SSI rate for clean was 5.4% , for clean- contaminated was 35.5% and 77.8% for contaminated operations.[27]

Shojaei H, in 2006 studied a total of 845 clean surgical wound cases and the infection rate was found to be 4.9%.The most common organism isolated in clean surgical procedure was Staphylococcus epidermidis(74%),Staphylococcus aureus (17%), Enterobacter aerogenes (5%).Most of the infection were around 40 age groups and infection rate was more in patients with surgical drains and during long duration of surgical procedure.[28]

SURGICAL SITE INFECTIONS:

The infections occurring along the surgical tract after an operative procedure. They are classified as superficial incisional, deep incisional and organ/space infections[29]

DEFINITION:

SSIs occurring within one month of surgery or within 1 year after a surgical procedure using implants and foreign material such as mesh, vascular graft, prosthetic joint. The most common are incisional infections accounting for 60% to 80% of all SSIs and having better prognosis than organ/space- infections which accounts for 93% of all SSIs.[30]

CLASSIFICATION:[31]

Centers for Disease Control and Prevention of Surgical Site Infection (SSI),according to which it is classified as follows

1. Superficial Incisional SSI

Infection occurs within 1 month of surgery involving only skin or subcutaneous tissue of the incision and at least one of the following:

1. Purulent drainage from the superficial incisional wound with or without laboratory confirmation.

2. Organisms isolated from a pus exudates obtained in aseptic manner from superficial incisional wound.
3. Presence of one of the signs or symptoms of infection such as pain, localized swelling, tenderness , redness or heat .
4. Deliberate opening of superficial incision by a surgeon and culture growth is negative.
5. Diagnosis by the attending surgeon or physician of superficial incisional SSIs.

2. Deep Incisional SSI

Infection occurs within 1 months of surgery if no implant is used or within 1 year if implant is used and the infection is related to the surgery involving deep soft tissues (e.g., muscle and fascial layers) of the incision and at least one of the following:

1. Deep incisional wound with purulent discharge.
2. Spontaneous dehision of deep incisional wound.
3. Presence of , localized pain or tenderness, fever (>38ºC).
4. Deliberate opening of incision by surgeon.

5. Deep incisional infection diagnosed during wound examination, re-operation, histopathologic or radiologic examination.
6. Physician or surgeon diagnosing deep incisional infection.

3. Organ/Space SSI

Infection occurring within 1 month of surgical procedure if no implant used or within 1 year if implant used and the infection is related to surgery and infection involves any organs or spaces, other than the incision and it was opened or manipulated during an operation and has one of the following:

1. Purulent discharge from drain placed through stab wound into organ/space.
2. Organisms isolated from purulent discharge which is obtained aseptically from organ/space.
3. Presence of abscess or signs and symptoms of infection involving the organ/space during direct examination, during reoperation, histopathologic or radiologic examination.
4. Physician or surgeon diagnosing organ/space infection.

SURGICAL WOUND[31]

The wounds were classified using wound contamination classification system, proposed by US National Research Council(1964). This classification system is widely used to predict infection occurring after surgery.

CLASSIFICATION OF WOUNDS IN SSI

Clean wound:

- Elective, primarily closed, no acute inflammation encountered
- No entrance of normally or frequently colonized body cavities (oropharyngial, biliary, genitourinary, gastrointestinal or tracheobronchial tracts) and
- No break in surgical technique.

Clean contaminated:

- Non elective cases that is otherwise a clean.
- Controlled opening of normally colonized body cavity.
- Minimal spillage or break in sterile technique.
- reoperation through clean incision within7 days.

Contaminated:

- Acute non purulent inflammation encountered.
- Major break in technique.
- Spill from hollow organ.
- Penetrating trauma less than 4 hours old.

Dirty:

- Abscess encountered or drained.
- Preoperative perforation of colonized body cavities.
- Penetrating trauma more than 4 hours old.

Based on ***source of infection*** they are classified as

1. **Primary**:

Present in the host and acquired from endogeneous source

2. **Secondary**:

Present outside the body acquiring from exogeneous source such as operation theatre (inadequate air filtration, poor antisepsis) or the surgeon(poor hand washing).

Wound can be classified according to ***severity*** as

1. **Major**:

Discharge significant quantity of pus with systemic signs such as tachycardia ,pyrexia and raised WBC count.

2. Minor:

Discharge minimal quantity of pus with no systemic signs

Based on the period of infection they are classified as

a) Early:

Infections presents within 30days of surgical procedure.

b) Intermediate:

Infections occur between one and three months of surgery.

c) Late:

Infections presents more than three months after surgery.

PATHOPHYSIOLOGY OF WOUND HEALING[32]

The response to injury either surgically or traumatically induced, is immediate and the damaged tissue or wound then pass through the following three phases in order to effect a final repair. Various phases of wound healing are

1. Inflammatory phase
2. Fibroplastic phase
3. Remodelling phase

1. INFLAMMATORY PHASE:

For proper healing to occur inflammation is necessary.It immobilizes the wound by causing it to swell and prepares the area for healing . Vascular flow changes are responsible for symptoms used to detect inflammatory response. Specialized cells from blood is involved in the inflammatory phase.

During injury blood vessels will be damaged and from these vessels cut end ,blood enters the wound which then coagulates and blocks lymphatic channels and damaged blood vessels and prevents further blood loss. The injured tissue releases **histamine** and causes dilatation of neighbouring blood vessels. This results in release of blood exudates and serous transudate thereby causing inflammatory signs such as redness, heat , pain and swelling.

Bradykinins released at the injured site , cause vasodilatation and increase vascular permeability**. Prostaglandins** are also released, which further causes long term vasodilatation. Fibrin plugs are formed in the lymphatic vessels, which clot and seal the leakage from the wound. Lymphatic vessels blockage seals the wound and prevents the spread of infection.

a.Phagocytosis:

White blood cells will attach to the dilated endothelial walls of adjacent blood vessels. Chemokines produced at the wound site stimulate the white blood cells to migrate towards the injured site.

Within a few days of injury, more number of macrophages were present in the wound and it remains there until inflammation ceases. Macrophages play a vital role in wound repair. They are

1. Removal of dead and devitalized tissue .
2. Phagocytosis of pathogenic organisms.
3. Lymphocytes and other immune cells were stimulated by macrophages.

Macrophages will attach to the bacteria and engulf it and also remove the necrotic tissue present in the wound. Macrophages influence wound repair by chemically stimulating fibroblasts. Fibroblasts are also stimulated by platelets through platelet derived

growth factor. These fibroblastic cells play a vital role in wound healing by secreting extracellular matrix components and providing structural framework for the tissues.

b.Neovascularisation:

Healing will occur, only in the presence functioning blood vessels. Oxygen and nutrients will be supplied to the damaged tissue from the blood vessels. Patent vessels present in the wound develop small buds that grow into the wound and join up with other arteriolar and venular buds to form capillary loops. Thickness of capillary loop initially formed is very low and more prone for damage. For that mobility has to be restricted so that blood vessels will regrow and bleeding will not occur . Fibrinolysin produced in blood vessels in the end phase dissolves the clot followed by opening of lymphatic channels thereby decreasing the swelling of wound.

In healthy persons, these process occur in the initial period of injury and the main aim of treatment is minimization of all factors interfering with inflammatory process.

2.FIBROPLASTIC PHASE:

Rebuilding occurs during this phase It last for 21 days and strengthening and restructuring of wound occurs during this phase and all the damaged structures were surrounded by fibroblastic cells. Migratory fibroblasts reach the wound depth and stimulates collagen synthesis .Three important process occurring in this phase are epithelisation, contraction of wound and production of collagen.

a.Epithelisation:

This is an important event occurring early in the process of healing. The factor necessary for survival of tissue are, removal of necrotic tissue by phagocytosis, adequate blood supply and epithelisation of wound .Thus skin coverage is very helpful in protecting the wound from invading microorganisms from external environment.

Following injury normal epithelial cells present at the margin of wound undergoes multiplication to form a ridge. Adjacent epidermal structures also multiply to protect the wound after injury. If there is sufficient supply of blood, these newly formed cells will migrate from periphery to inside the wound and this migration will cause tension on normal skin near the edge of wound.

In the presence of excessive necrotic tissue or poor availability of oxygen, epithelial migration cannot occur and epithelial integrity is not maintained and this will lead to wound dehiscence. Even though clean wound heal within 2 days, larger wounds will take longer time to heal.

b. Wound contraction:

Wound surface are covered during epithelisation and wound edges are pulled together during contraction of wound. It results in shrinkage of wound defect. Wound contraction also decrease the surface area of wound which is repaired by formation of scar. Wound contraction may be harmful in areas such as hands and face, as anatomy of the skin was distorted and tissue was retracted towards the healing site resulting in disfigurement.

c. Production of collagen:

Collagen formation occurs at the end of wound healing process. Fibroblasts are stimulated to synthesize collagen molecule. Oxygen, vitamin C , copper, zinc and iron are needed for collagen formation.

Fibroblast synthesizes procollagen and they are released into extracellular space. These procollagen are converted into tropocollagen and they arrange to form collagen fibril. Fibroblast

also synthesizes glycosaminoglycans which fills the space around collagen. Cross links formation occurs , which restricts the mobility of tissue . Thus Glycosaminoglycans and collagen forms the scar.

REMODELLING PHASE

Increased synthesis of collagen without increase in scar mass takes place due to balance between the formation of new collagen and removal of old collagen. This collagen turn over occurs for six months or one year depending upon the severity of injury and it results in proper arrangement of deposited scar tissue.

WOUND HEALING:[33]

Healing of surgical wound takes place at three level, they are

1.Primary healing of wound

2.Secondary healing of wound

3.Tertiary healing of wound

1. PRIMARY INTENTION:

This type of healing occurs in most of the wound . wound edges are approximated with the help of sutures and adhesive strips and allowing the wound to heal and acquire enough strength to overcome stress . Main aim of surgery is to allow the wound to heal naturally and with minimal formation of scar.

2. SECONDARY INTENTON:

Healing by secondary intention occurs when there is delayed closure of wound due to excessive trauma, increased skin loss, presence of infection causing organism at wound site. Wound healing occurs by granulation tissue formation and wound contraction.

3. TERTIARY INTENTION:[34]

In this type of healing, dead tissues were removed and wound will be sutured after 4-6 days, before the appearance of granulation tissue . This method of healing occurs in wound due to traumatic injury or after surgery on dirty wound .

FACTORS AFFECTING WOUND HEALING[35,36,37,38]

a. Aging

Swift 2001, observed that the physiological process during ageing, makes the older patients more prone for poor wound healing. Every phase of healing undergoes age related changes including delayed angiogenesis, decreased secretion of growth factors, impairment of macrophage function, delayed epithelisation, , reduced turnover of collagen and remodeling. Skin elasticity is reduced and collagen replacement is also poor and this in turn affects wound healing. As immunity decreases with ageing ,they

are more susceptible to infection. Chronic diseases are more common in older age group since this will affect the circulation and oxygenation to the wound bed.[39]

b.Obesity:

Anaya and Dellinger et al., and Demello, observed that obesity is related to defective wound healing, due to impaired tissue perfusion. Increased tension on wound edges results in wound dehiscence and also reduces microperfusion thereby decreasing the oxygen availability to wound .[40]

c.Stress:

Kiecott-Glaser et al., 1995 observed that physiological stress is associated with poor wound healing. During Stress normal cell mediated immunity is impaired and wound healing is delayed .[41]

d.Diabetes:

Studied conducted by several people revealed that, vascular changes occurring in diabetic patients results in hypoxia, impaired angiogenesis and neovascularisation and dysfunction of fibroblast leading to impaired wound healing.[42]

e. Dehydration:

Electrolyte imbalance that occurs during dehydration will affect cellular function and wound healing. So fluid resuscitation has to be done in post operative patients to prevent hypovolemia.

f. Effective hand washing :

Transfer of pathogenic organisms through person or objects were prevented by simple hand washing technique.[43]

g. Medication:

Hoffman et al., studied that drug such as anticoagulants, immunosuppresants, anti-inflammatory and cytotoxic drugs, reduce wound healing due to its interference with cell division or clotting process.

h. Nutrition:

Studies conducted by Campos et al., revealed that Protein is essential for wound healing and wound healing will be delayed in case of protein calorie malnutrition.[44]

- Maintenance of blood sugar level is essential for wound healing to occur.
- Oxygen is an essential factor in the hydroxylation of aminoacid proline and lysine during collagen synthesis, an increased

incidence of abdominal wound dehiscence has been reported in anaemic patients.[46]

- For proper functioning of immune system, minerals such as copper and zinc were essential. Heyman et al., observed that zinc deficiency leads to defective formation of granulation tissue and has adverse effects on cell multiplication, fibroplasias, collagen synthesis and epithelial covering of wounds.
- Vitamins A, and C plays a vital role in collagen synthesis. Studies conducted by Arnold showed that vitamin deficiency results in defective immunity and poor wound healing.
- Fats and Carbohydrates: Energy required for wound healing will be provided by carbohydrates and also by fats.

i.Oxygenation:

Rodriguez et al., 2008 observed that, for proper wound healing to occur, oxygen is essential, as it influence epithelization, and provides immunity to patients. So hypoxemia results in poor wound healing. [45]

j.Smoking:

Soresen in his studies observed that smoking causes impaired healing of wound due to its vasoconstrictive effects on blood vessels.[46]

RISK FACTORS OF SSI:[47,48]

Multiple risk factors are involved in surgical site infections. Among these three major determinants are

A. Bacterial factors

B. Local wound factors

C. Patient factors.

A. Bacterial factors:

1. Infection at remote site.
2. Recent hospitalization.
3. Long duration of procedure.
4. Different class of wounds.
5. Antibiotics given previously.
6. Preoperative shaving.
7. Bacterial number, virulence and antimicrobial resistance.

Bacterial factors causing infection were it virulence factors and number of bacteria present at the surgical site. The development of surgical site infection depends on the ability of the microorganisms to produce toxins and to resist phagocytosis and intracellular destruction. Surface components of bacteria plays a vital role in the pathogenesis(example: capsule of klebsiella and streptococcus pneumonia,the slime of coagulase negative

staphylococci). Endotoxin or lipopolysaccharides produced by Gram negative bacteria are toxic and powerful exotoxin produced by Streptococci and Clostridia can cause invasive infection even with small inocula. Though most of the organisms produce infection after five days of operation, streptococcus or clostridia produce infection within 1 day.

Various studies conducted on traumatic wounds revealed that contamination of wounds with bacteria of >10^5 organisms frequently causes infection. But ß-haemolytic streptococci cause infection even with minimal load. Thus the normal defence mechanism is very important in preventing surgical site infections but infection will occur if bacterial load is high. This observation leads to wound classification and the wounds have different numbers and types of bacteria depending on the surgical site and techniques used. Studied conducted during varying periods shown that incidence rate of SSI were more with longer preoperative stay, shaving done before surgery ,increased duration of surgery and infection present at remote site.

B. Local wound factors:

1. Blood supply.

A good blood supply is an essential factor in the process of wound repair because it will provide oxygen and nutrients necessary for cellular and biochemical process of wound repair and it is also necessary for removal of wound metabolites.

Any factor causing mechanical tension in the wound will have adverse effect on blood supply. In the early stages of wound healing during inflammatory phase, there is some degree of swelling of wound and during this stage sutures are not to be tied too tightly as this may have an adverse effect on blood supply

2. Surgical technique.[49]

The most important factor in the pathogenesis of wound infection is the skill of the surgeon. Good surgical technique includes gentle handling of tissue, maintaining hemostasis and avoiding dead space in the wound

3. Hematoma and necrosis.

Hematoma or collection of serous exudates occurs when dead space exists in the wound. This can be reduced or obliterated by external mechanical pressure or use of wound drains .The necrotic tissue present in the wound causes tissue swelling and this will

decrease the blood supply to the wound and the presence of these substances in the wound acts as a good culture media for bacterial growth thereby causing delayed wound healing.

4. Sutures.

Ideal suture should hold the tissue in opposition and cause only minimal tissue reaction and it should be quickly absorbed so that infection is not encouraged.

5. Drains.

Bacterial contamination of wound was more with the usage of drains, Lilani SP, in his study observed that SSIs rate was 22.41% in cases where drain were used when compared to 3.03% in cases where drain was not used [50]

6. Foreign bodies.

It depends on the invasiveness of operation and surgical skills, as surgery breaks the barrier defence mechanism.

C. Patient related factors:

1. Age
2. Immunosuppression.
3. Malnutrition.
4. Steroid.
5. Malignancy.

6. Obesity.
7. Diabetes.
8. Smoking.
9. Perioperative transfusion.

Maintaining normothermia and delivering oxygen at fio2 of 80% or higher during the operation and control of blood glucose level in the perioperative period can reduce surgical wound infections.

Age:

Extremes of age have thought to influence wound infection due to decreased immunocompetence.

In a prospective study of 8474 patients Mead et al., demonstrated increased incidence of clean wound infection in patients less than 1 year or greater than 50 years(1.8%) versus those 1-50 years old(0.7%).Even clean contaminated wound have increased infection rate in a study conducted by Chesson.

Diabetes:

Several studies shown that diabetes, remains a significant risk factor in wound infection. In the 5 year study of Cruse and Foord, clean wound infection was 10.7% in diabetes compared with overall clean wound infection rate of 1.8%.

RISK SCORES FOR SSI:[52]

In the original SENIC study in 1985, Haaley et al demonstrated a contaminated or dirty wound to predict infection. In the original SENIC study in 1985Haley et al assessed the risk of infection by giving one point to each of the following

1. Contaminated operations.
2. Abdominal operations.
3. Operation lasting more than 2 hours.
4. More than three diagnoses exclusive of wound infection.

Score of 0,1,2,3,4 indicated a risk of 1,3,17,28 respectively. One weakness of the senic index is employment of the number of discharge diagnoses, since this number can be determined accurately only at the time of discharge.

In Culver modification of SENIC index published in 1991 wound classification was the only risk factor unchanged from the original index. In the National Nosocomial Infections Surveillance system based SSI risk index, each operation is scored by counting the number of risk factors present among the patient having American society of Anesthesiologists (ASA) pre operative assessment score of 3,4 or 5;operation classified as contaminated or dirty infected and an operation with duration of 'T' hour, where T depends on operative procedure being done.

ETIOLOGY OF SURGICAL SITE INFECTION[53,54]

Multiple factors are involved in SSIs and the contribution of these factors varies in different types of surgery. The source of infections can be exogenous or endogenous. Majority of the infections are endogenous and they will be present on the body surface or hollow viscera and contaminate the wound. Rarely infection was caused by pathogenic organisms present in the external environment such as air of operation theatre, implants, equipments and gloves used during surgery.

The bacteria involved in surgical site infections are broadly classified based on the

1) **Shape:** They are classified as cocci and bacilli.
2) **Gram staining characteristics:** They are classified as Gram positive and Gram negative bacteria.
3) **Oxygen requirement**: They are classified as Aerobic, facultative anaerobic and anaerobic bacteria.

Gram positive Cocci:

Among all Gram positive organisms Staphyloccus aureus is the most common pathogen associated with wound infections. Development of resistance to penicillin is more common with staphylococcus aureus and they require treatment with penicillinase

resistant antibiotics and extensive use of ß lactam antibiotics resulted in the emergence of MRSA. Staphylococcus epidermidis can cause infections in patients who had undergone extensive surgery especially those , having prosthetic or intra vascular devices.

Among the streptococcal species, ß haemolytic streptococci are rarely isolated in the wounds of soft tissue and cause serious manifestations.

Enterococci occur as a part of mixed flora in intra abdominal infections. Occurrence of Enterococcal bacteremia in surgical infections is associated with bad prognosis and pathogenic importance of Enterococi is due to its development of resistance to antibiotics. Effective antibiotic combination for treating Enterococci is Gentamycin and Ampicillin or Gentamycin and Vancomycin. Vancomycin resistant enterococci is emerging recently and causing serious infections in hospitalized patients

Aerobic and facultative Anaerobe:

Most of the Gram negative bacilli causing surgical site infections belongs to Enterobacteriaceae family. They are facultative anaerobes and the most common organisms causing surgical site infections belongs to three genera namely Escherichia, Proteus and

Klebsiella. Infections caused by this organisms are usually polymicrobial and other genera causing surgical site infections include Enterobacter, Morganella, Providencia and Serratia. These organisms are acquiring extended spectrum ßlactamase , which inactivate third generation Cephalosporins.

Obligate aerobic rods that can cause infection include Pseudomonas and Acinetobacter species.

Anaerobes:

They occur as normal commensal in the gastrointestinal tract. Among the anaerobes Bacterodes fragilis were more common. They are obligate anaerobe and it needs anaerobic environment for the production of toxin and for its growth and survival. The other important Anaerobic bacteria causing SSIs is Clostridium. They are spore forming Gram positive rods and growth occurs only in areas with low oxygen tension. Thus recovery of these organisms indicates the presence of dead tissue in the wound. Gastrointestinal tract is the important source for anaerobic bacteria and presence of these anaerobic organisms in these areas indicates that mucosal integrity of the gastro intestinal tract were lost.[57]

Fungi:

Among the fungus candida is the most common organism causing infections in surgical patients.

Thus the common organisms causing SSIs are Staphylococcus aureus, Coagulase negative Staphylococci, Enterococci, Proteus, Pseudomonas, Escherichia coli.

Staphylococci is the predominant organism causing infections in patients undergoing surgery for clean wounds, as they are skin commensal that will be present at the site of most incisions. Gram negative organisms will be present in the perineum, axilla and groin. So patients having incisions in these areas will be infected with these Gram negative organisms.

Bacteria from respiratory, genital, gastrointestinal and urinary tract usually cause infection in clean contaminated and contaminated surgeries. Gram negative organisms are the frequent cause of surgical site infection in procedures involving lower gastro intestinal tract. In surgeries on dirty wounds infection causing organisms present already in the operative field will cause SSIs.[58]

Various studies were conducted to find out the most common organisms involved in surgical site infection, they were

Chia JYH conducted studies on 150 cases of SSIs between 1990 and 1991. According to his studies, the most commonly isolated organism was Staphylococcus aureus (58.1%), followed by Streptococcus species (10.5%), Klebsiella species (9.5%), Enterobacter species (5.7%), Pseudomonas aeruginosa (4.8%), Escherichia coli (3.8%), Proteus species (2.9%) and Acinetobacter species (2.9%). [59]

Anvikar et al., conducted study in 1997 and 1998 and he observed that the most common isolate in clean surgical wounds was Klebsiella pneumoniae (26.8%), followed by Staphylococcus aureus (25%), Pseudomonas aeruginosa (21.3%), Proteus mirabilis (2.9%), Streptococcus pyogenes (2.3%), Klebsiella oxytoca (2.0%)and Proteus vulgaris (1.45%). [60]

Giacometti A studied 676 cases of SSIs between 1993 and 1999 and he found that the most common organisms causing SSIs were Staphylococcus aureus followed by Pseudomonas aeruginosa Escherichia coli Staphylococcus epidermidis and Enterococcus faecalis .[61]

Study of 406 post-operative clean wounds conducted by Murthy R in 1998 showed that Staphylococcus aureus (32%) and Pseudomonas species (21%) were the commonest organisms isolated. [62]

Kaplan NM studied 1319 surgical wounds between 1998 and 2002. Staphylococcus aureus were the common organism (42%) isolated followed by Escherichia coli (27.7%), Klebsiella species (20.5%), Pseudomonas species (5.3%), Enterococcus species (2.7%) and anaerobes (1.8%).[63]

Umesh SK studied 35 cases of SSI in 2005 and found the most common causative organism to be Pseudomonas species (22.9%) followed by Staphylococcus aureus (19.7%) Acinetobacter baumanii(14.8%), Klebsiella species (13.1%), Escherichia coli (11.5%), Citrobacter diversus (8.2%), Citrobacter freundii (6.6%).[64]

PATHOGENESIS OF SURGICAL SITE INFECTION:[65,66]

The important feature of SSIs is necrotizing infection of tissue. Pathophysiological process induce tissue necrosis in primary surgical infection. where as in post traumatic surgical infection physical or technical trauma induces tissue necrosis. Inflammation is the response to tissue necrosis and results in specific inflammatory signs such as rubor, tumor, calor, dolor and functiolaesa. These signs reflects host response to injury and if it is controlled and regulated properly , necrotic tissue will be eliminated and tissue repair occur in a proper manner.

Inflammatory response and presence of symptoms depends on the number and virulence of pathogenic organisms. When there is continuous production of toxins and host capability to fight against it was diminished the inflammatory process will continue to end up in multisystem malfunction. Pathogenesis of infection takes place at two levels,they are

1. Local phase
2. Systemic phase

Local factors of infection:

Once infection occurs it will progress rapidly and macrophages were not able to phagocytose all dead cells and the remaining necrotic tissue acts as a good culture medium for the growth of bacteria. Bacteria further releases toxins which invade the surrounding tissue and the host will respond to that in order to confine the infection.

Abscess formation occurs when the extent of tissue injury and bacterial load is more and it exceed the capacity of host to terminate an infection . During the inflammatory process, fibrin deposition occurs to confine the infection before the bacterial toxin destroys the tissue and a pyogenic membrane is formed. Formation of abscess is more in areas with decreased ph , increased pressure and oxygen tension is low . This will acts as a culture medium for the multiplication of bacteria.

Systemic phase:

When local control of infection is not possible, microorganisms invade the blood stream and reach distant organs. Bacteria which is not producing toxin and not multiplying were rarely isolated in blood culture. It usually causes mild symptoms in

normal patients and cause severe systemic manifestations in post operative cases and in patients taking immunosuppressant drugs.

Sepsis occurs due to multiplication of bacteria in the blood and progress to shock. Patient will be having persistent arterial hypotension that do not resolve even after fluid resuscitation..

Pathogenesis of infection:

There is a significant correlation between different types of surgery and wound infection. According to contamination of wounds by bacteria wounds are classified as Clean, Clean contaminated, Contaminated, Dirty.

Contaminated surgery refers to operations undertaken in the presence of established sepsis. The operations for peritonitis, perforated appendicitis and drainage of abscess are included in this category and wound infection occurs in 40-60% of cases.

Clean contaminated surgery refers to operations in which surgical procedure includes exposure of wound to bacterial contamination. Operations on the hollow viscera are included in this category and also includes operations on the biliary tract, gastrointestinal tract and urinary tract. Incidence is around 10-20%.In clean surgery there is no septic hazard in the surgical

procedure and wound infection results from contamination of organisms from patients skin surface or from the environment. Operations included in this category are plastic, neurosurgical, orthopaedic, cardiovascular, breast surgery and herniorraphy and infection rate is around 2-4%.(48)

Cross infection:

Exogenous infections occur in the operating room during exposure of wound. At the end of surgical procedure more number of bacteria will be present in the wound and this will cause wound infection and longer the duration of surgery more is the contamination of the wound.

Infecting organism

Most bacteria recovered from surgical wounds are opportunistic pathogens, they are commensal organisms found on hollow viscera or skin surface and they cause wound infections if they are inoculated into wound in sufficient numbers

Most infections result from spillage of bacteria into the wound during operations on biliary or gastrointestinal tract .Infections following gastric surgery are caused by oral commensals for example; diptheroid species. Wound infections following biliary surgery are caused by E.coli, Streptococcus faecalis, Enterobacter aerogenes. Non sporing anaerobes cause wound infection in surgeries on colon and rectum.

Minority of surgical site infections are caused by pathogenic bacteria and among these staphylococci are more common. These organisms cause severe infections in clean surgeries. Thus infections in Hernia repair, plastic surgery, Orthopedic surgery results in failure of surgery and infections in cardiovascular surgery results in hospital mortality.

CLINICAL FEATURES:[67]

The infected surgical wound presents with the following signs and symptoms such as,

1. Increased redness around the wound.
2. Increased pain at wound site.
3. Swelling of the wound.
4. Discharge of pus from the wound.
5. Increased local temperature.

When the pathogenic organisms enters the blood stream , following signs and symptoms will occur such as,

1. Fever with malaise.
2. Tachycardia.
3. Raised leucocyte count.
4. Discharge of significant quantity of pus from the wound.

MANAGEMENT[68]

The management of surgical site infections includes,

1.General management.

2.Local management .

3.Systemic management.

1. General management:

- Adequate nutrition has to be maintained .
- Temperature chart has to be maintained to prevent hypothermia.
- Intake output chart has to be maintained to prevent hypovolemia.
- Blood sugar level was maintained at normal level as there is increased risk of infection in diabetic patients

2. Local management :

Surgical principles in the management of wound infection are

a) Drainage of pus.

b) Debridement of necrotic tissue and dressing of wound.

c) Wound closure .

The most important aspect in the management of SSIs is wound care and most important step in wound care is to protect the wound in the form of dressing. Dressing should be done in such a way that necrotic tissue should be removed, should absorb excess exudates present in the wound, Protect the wound and prevent bacterial contamination of wound.

3. Systemic management:

Antibiotics should be started if the patient has following signs;

a. Rise in temperature.

b. Swelling of the wound.

c. Pus discharge from the suture line

Broad spectrum antibiotics should be given initially and later specific antibiotics, according to the culture and sensitivity of organisms.

PROPHYLAXIS[69,70,71]

Antimicrobial prophylaxis:

The aim of antibiotic prophylaxis is to ensure effective serum and tissue level of drugs during surgery. certain guidelines were recommended to start antimicrobial prophylaxis before surgery , they are

- Prophylactic antibiotics should be initiated within 1 hour before incision
- Antibiotics should be administered in accordance with surgical procedure
- Prophylactic antibiotic should be discontinued within 24 hours of surgery except cardiothoracic surgery (discontinued within 48 hours).

A study of 2847 patients undergoing clean or clean contaminated surgeries revealed that, the patients receiving antibiotics two hours before incision were associated with 0.6% infection rate when compared to two fold rise in infection rate in patients receiving antibiotics three hours after surgical incision and six fold rise in infection in patients receiving antibiotics more than two hours before incision

Multicentric study conducted in united states proved that of antibiotics administered within 1 hour before surgery reduce infection rate and this was reduced further if administered within 30 minutes before incision

Single infusion of antibiotics given 1 hour before incision gives sufficient protection and it has to be repeated intra operatively for procedures lasting more than 24 hours and when substantial blood loss occurs. Antibiotics must be present in the surgical site throughout the surgical period.

There is no benefit in continuing antibiotic prophylaxis after 24 hrs of surgery except cardiac surgery. Antibiotic usage varies according to the causative organisms. Staphylococcal infection is more common following clean surgery. Mixed infection are common in clean contaminated surgery are mostly mixed infection and are usually caused by human endogenous flora. Antibiotic prophylaxis with cefazolin is inadequate in certain cases due to the presence of anerobic bacteria such as enterococci and bacteroides .

Certain prophylactic measures to be followed to ***reduce the bacterial contamination*** of wound are,

1. PREOPERATIVE FACTORS:

- Avoid preoperative antibiotic use (excluding surgical prophylaxis)
- Minimize preoperative hospitalization
- Hair removal using electric clippers or depilatories.
- Ensure timely administration of antibiotics.
- Elimination of nasal carriage of staphylococcus aureus.

2. INTRAOPERATIVE FACTORS:

- Preparation of patient skin with povidone iodine or chlorhexidine solution.
- Follow antiseptic techniques strictly.
- Maintain high flow of filtered air.
- Maintain laminar flow environment.
- Reduce prophylactic antibiotics in prolonged surgeries
- Minimize flash sterilization of surgical instruments
- Minimize use of drains

Measures to ***improve host resistance*** to contaminating bacteria

PREOPERATIVE FACTORS

- Resolve malnutrition or obesity.
- Discontinue cigarette smoking.
- Maintain blood sugar level.

INTRAOPERATIVE AND POSTOPERATIVE FACTORS

- Minimise dead space, devitalized tissue and haematoma.
- Supplemental oxygen therapy.
- Maintain perioperative normothermia. Maintain adequate hydration and nutrition.

MATERIALS & METHODS

MATERIALS AND METHODS

The present study on Bacteriological profile of surgical site infections and antibiogram was carried out in the Department of Microbiology, in a tertiary care hospital from August 2013 to July 2014.A total of 220 clinically diagnosed case of SSIs were taken for study.

The materials for the present study was obtained from patients, who had undergone operations in the departments of Surgery, Obstetrics and Gynaecology and Orthopaedics, and who had developed signs and symptoms of postoperative wound infections.

INCLUSION CRITERIA

Clean, Clean Contaminated, Contaminated, Dirty surgeries conducted in the departments of Surgery, Obstetrics and Gynaecology and Orthopaedics.

EXCLUSION CRITERIA

Procedures in which healthy skin was not incised, such as opening of an abscess.

Infection of burn wounds.

Surgeries conducted in other specialities.

SAMPLE COLLECTION

All clinically diagnosed cases of surgical site infections classified under CDC guidelines were included for sample collection. The wounds were examined for signs and symptoms suggestive of surgical site infections during the post operative period and sample was collected if the surgical site was found to be infected according to the criteria recommended by surgical wound infection task force. Before collecting the sample, careful cleaning of infected surgical site has to be done using 70% ethyl alcohol followed by 10% povidone iodine and allowed to remain for 2 minutes.

Wearing a sterile gloves the wound margins were separated with thumb and forefinger of one hand and with the other hand gentle pressure is applied and pus exudate was collected from the depth of the wound using two sterile cotton swabs for aerobic culture and for anerobic culture, the pus was aspirated in a sterile syringe or whenever possible.

TRANSPORT:

All the specimen collected were transported immediately to the laboratory for further processing. The Robertson cooked meat media were incubated at 37°C.

PROCESSING OF SPECIMEN:[72,73,74]

The samples collected were processed as follows

- Direct microscopic examination of Gram stained smear.
- Inoculation of samples into Nutrient agar, Blood agar, MacConkey agar and selective media such as Mannitol salt agar. Robertson cooked meat media was inoculated for the isolation of anaerobic organisms.
- Preliminary identification of growth by colony morphology.
- Biochemical tests for characterization of species.
- Antibiotic sensitivity test.

Direct Gram stain:

Using the first swab, a smear was made on a clean glass slide and stained by Gram staining method. The smear was screened for the presence of pus cells, the Gram reaction, size, shape, Arrangement and types of organisms.

Culture for Aerobic organisms:

Using sterile bacteriological loop The swab was inoculated into Nutrient agar plate, 5% sheep Blood agar, MacConkey agar and incubated at 37°C for 24-48 hrs. The blood agar was incubated at 5-10 % CO2.

IDENTIFICATION TESTS:[76]

Primary plates were observed for any visible growth after 24 hours. Colonies were examined macroscopically using a magnifying lens and the colony characteristics were recorded. Smear was made from isolated colonies, stained by gram staining and examined under oil immersion objective for the size, shape, Gram reaction, arrangement .

1. Nutrient agar:

After 24 hours of incubation , colony characteristics like size, shape, surface, margin, edge, consistency, pigmentation, etc were noted.

2. MacConkey Agar:

After 24 hours of incubation, colony characteristics like size, form, elevation, margin, surface, consistency were noted along with colour to detect the lactose utilizing properties of the organisms. On Gram staining, often Gram negative bacilli and sometimes pleomorphic and coccobacillary forms were seen

3. Blood agar:

After 24 hours of incubation, colony characteristics like size, form, elevation, colour, margin, surface and consistency were observed. The plates were examined to detect hemolytic reactions in

the agar. Convex 2-3 mm white opaque colonies with entire edges, often ß hemolytic colonies were seen. On Gram staining Gram positive cocci arranged in pairs, chains, clusters were seen.

All members of Enterobacteriaceae produced large, grey, dry or mucoid colonies on blood agar.

Based on the above observations, organisms were grouped into Gram positive (cocci or bacilli) and Gram negative (coci or bacilli). They were identified by standard procedures.

Gram negative bacilli were confirmed by

Catalase test:

1 ml of 3% hydrogen peroxide was taken in a sterile test tube. Few colonies were taken from the Nutrient agar plate with a thin glass rod. The glass rod was inserted into the hydrogen peroxide solution.The production of immediate and sustained effervescence indicates positive test.

Oxidase test (Dry filter paper method):

A small amount of colony was streaked onto moistened filter paper disks, impregnated with freshly prepared 1% tetramethyl para phenylene diamine dihydro chloride. An intense deep blue colour, appearing within 5-10 seconds was taken as positive reaction.

Motility test

Motility was tested by hanging drop preparation method.

BOCHEMICAL TESTS

a) Indole test

b) Methylred test

c) Voges proskauer

d) Citrate utilization

e) Urease production

f) Sugar fermentation

g) kliggler iron test

h) Mannitol motility test

IMVIC TESTS:

Indole tests:

Inoculating the test organisms in 2-3 ml of peptone water and incubating for 18 to 24 hours at 35°C . To this kovac's reagent(0.5 ml) was added and shaken gently. The test was interpretated as positive if there was change in colour to red or negative if there was no change in colour.

METHYL RED TEST:

A pure culture of the test organisms was inoculated into 5 ml of glucose phosphate broth which was incubated for 48-72 hours at 35°C and 5 drops of methyl red reagent was added. The development of bright red colour indicated a positive test and negative was yellow.

VOGESPROSKAUER TEST:

Glucose phosphate broth(5 ml) was inoculated with a pure culture of the test organisms and incubated at 35°C for 24 hours and to this 3 ml of 5% solution of alpha naphthol followed by 1ml of 40% KOH was added and shaken gently Acetoin formation was indicated by the appearance of eosin pink colour in 10-15 minutes.

CITRATE UTILIZATION TESTS:

A well isolated colony was picked up from the MacConkey agar plate and inoculated onto the slant surface of Simmon's citrate agar medium and incubated at 35°C for 24 to 48 hours. Colour change of the medium from green to deep blue with visible colony growth along the streak line was interpretated as positive.

UREASE TESTS:

The surface of christensen's urease agar slant was inoculated with loopful of pure culture of test organism and incubated at 35°C for 18 to 24 hours. Colour change of the medium from original yellow to purple pink and growth is seen along the streak line was taken as positive.

SUGAR FERMENTATION TEST

A single colony or a drop of liquid culture was inoculated into 5 ml of peptone water containing 1% sugars (Glucose, Lactose, Sucrose, Maltose, Mannitol etc),indicator Bromothymol blue and Durham's tube and incubated at 35°Cfor 24 to 48 hrs.

Interpretation:

Acid production: Blue coloured medium turns yellow due to acid production.

Gas production: Presence of gas bubbles in Durhams tube.

KLIGLER IRON AGAR TESTS:

Using a straight wire the colony was first stabbed into the butt of the KIA agar (Glucose, Lactose, Ferric salts and phenol red indicator) extending to within 3-5 mm of its bottom and when the inoculating wire was removed from the deep of the tube, slant

surface was streaked with back and forth motion and incubated at 35°C for 18 -24 hours. Phenol red was used as indicator which shows different colour at different ph.

Interpretation:

Alkaline(K) / Alkaline(K) : No fermentation of carbohydrate, characteristic of non fermenting bacteria such as Pseudomonas.

Alkaline (K) / Acid (A): Glucose fermented and lactose non fermented characteristic of non lactose fermenting bacteria such as shigella and salmonella.

Alkaline (K) /Acid (A) with H2S : Glucose fermented and lactose non fermented with H2S produced characteristic of non lactose fermenting H2S producing bacteria such as Citrobacter, Proteus, Salmonella.

Acid (A) /Acid (A): Glucose and lactose fermented characteristic of lactose fermentation .

Bubbles: Gas produced.

Blackening of medium: H_2S produced.

Mannitol motility test:

Straight wire was used to touch a pure colony growing on the agar medium and stabbed about half the depth of medium in

the middle of the tube containing mannitol motility test medium which was incubated for 18- 24 hours at 35°C .

Interpretation:

Motile: Diffuse zone of growth flaring out from the streak line .

Non motile: organisms were confined to line of inoculation.

Blood agar:

After 24 hours of incubation, colony characteristics like size, form, elevation, margin, surface, density and consistency were studied.

GRAM POSITIVE COCCI

Catalase test:

Catalase test were done by picking up few colonies from nutrient agar plate. Appearance of immediate and sustained effervescence indicates positive test.

Slide coagulase tests:

A colony suspected to be Staphylococcal species is emulsified in sterile saline on a clean glass slide to form a milky suspension. A drop of citrated human plasma was added to the suspension. A similar suspension was made with known staphylococcus aureus strains and coagulase negative staphylococcus strains to test the proper reactivity of plasma. Presence of coarse clumping of cocci

within 10 seconds indicates that organism was slide coagulase positive. It was confirmed by tube coagulase test

Tube coagulase tests:

Few colonies from blood agar plates were mixed with 0.5 ml of diluted plasma in the test tube. Positive control, Negative control and a tube of undiluted plasma were also set up. Tubes were incubated at 35°C for 4 hours. They were examined at 1, 2 and 4 hours for clot formation. The plasma was converted into a stiff gel that remained in place when the tube was tilted. If no clot was seen, the tube was re-incubated at room temperature and it was read again at 18 hours. Clot formation confirmed the slide test and the organism was identified as Staphylococcus aureus.

MANNITOL FERMENTATION TEST

Colonies of staphylococcus aureus was streaked onto mannitol salt agar (1% mannitol, 7.5% sodium chloride and phenol red and peptones) and incubated for 24- 48 hours at 37°C. High salt concentration of medium allows the growth of staphylococci and inhibit the growth of other organisms(except enterococci)

Interpretation:

Yellow zone around colonies indicating acid production from mannitol.

Detection of Enterococci:

Bile esculin test

Few colonies from 18-24 hours pure culture were inoculated onto the surface of bile esculin agar slant . Ferric ammonium citrate was used as an indicator and incubated for 24-48 hours at 35°C .

Interpretation:

Positive: Diffuse blackening of more than half of agar slant.

Negative: No blackening of medium was seen.

ANTIBIOTIC SENSITIVITY TEST:[75]

Antibiotic sensitivity of the isolates were tested using modified Kirby Bauer Disk diffusion method. Two to three colonies were taken from the primary culture plates with sterile bacteriological loop and suspended in a sterile saline in a test tube and the turbidity was compared and adjusted to 0.5 Macfarland standard.

0.5 Macfarland standard preparation:

0.5 macfarland standard is prepared by adding 0.05 ml of 1% anhydrous BaCl2 to 9.95 ml of 1% H2So4 in a test tube.

A sterile swab was dipped into the inoculum. Excess inoculum was removed by pressing the swab onto the sides of the tube, above the level of the inoculum. The swab was streaked into Muller Hinton agar plates. The plates was dried for few minutes with lid closed. Commercially available antibiotic disks obtained from Hi-Media laboratories ltd, were used. Using a pair of sterile forceps the antibiotic disks were placed on the inoculated plates and gently pressed to ensure even contact and incubated at 37°C.

After 16-18 hours of incubation the diameter of each zone was measured with a scale, recorded in mm and interpretated as sensitive or resistant according to the indications of disk manufacturer.

CULTURE OF ANAEROBIC ORGANISMS[72]

Under aseptic precautions , pus exudates was aspirated using sterile disposable syringe from post operative wound suggestive of anaerobic infections such as blood stained pus, foul smelling purulent discharge and black necrotic tissue.

The samples collected for anaerobic culture were processed as follows

1) Direct microscopic examination of Gram stained smear.
2) Inoculation of samples into Robertson cooked meat media broth.

Direct microscopy;

Direct smears were made from the pus and stained with gram stain. The smears were screened for the presence of pus cells, the Gram reaction, size, shape, arrangement and types of organisms.

Culture of anaerobic organisms;

The pus aspirated in the syringe were inoculated into RCM broth and incubated at 37° C for 7-14 days. The RCM broth was inspected daily for the presence of turbidity and colour change of the meat, indicating growth of anaerobic organisms. Smear made from the RCM broth showing turbidity and colour change.

On Gram staining , Gram positive cocci resembling Streptococci and Gram negative, pleomorphic rods with irregular staining were seen.

Subculture was done from the RCM broth into two plates of blood agar plates. One was incubated aerobically and other was incubated in a candle jar with 5% CO2 at 37°C for 24- 48 hours.

After the incubation period blood agar plate incubated in a candle jar was inspected and compared with blood agar incubated aerobically

Each type of colony was examined by Gram staining. Colonies that appeared only on blood agar incubated aerobically were probably aerobes and other incubated in a candle jar were considered as facultative anerobes.

If there was no growth on both blood agar plates , it was aerotolerance negative and considered as obligate anaerobes. Though presumptive identification could be that of Bacteroides and Peptostreptococci , further identification of these anaerobes could not be done in our present laboratory setup. Hence only presumptive identification of anaerobes were possible.

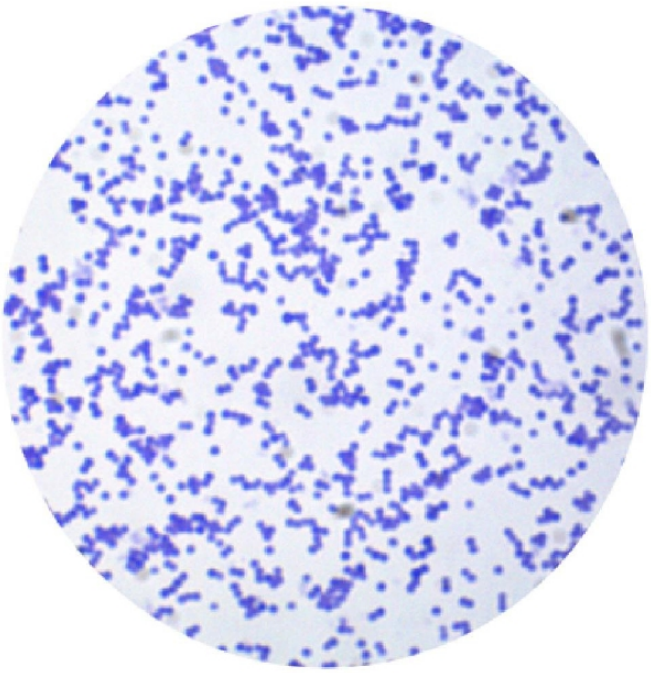


Fig 1: Gram's Stain Showing Gram positive cocci in clusters

Fig 2: Colonies of Staphylococcus aureus on blood agar plate

Fig 3: Colonies of Staphylococcus aureus with β hemolysis

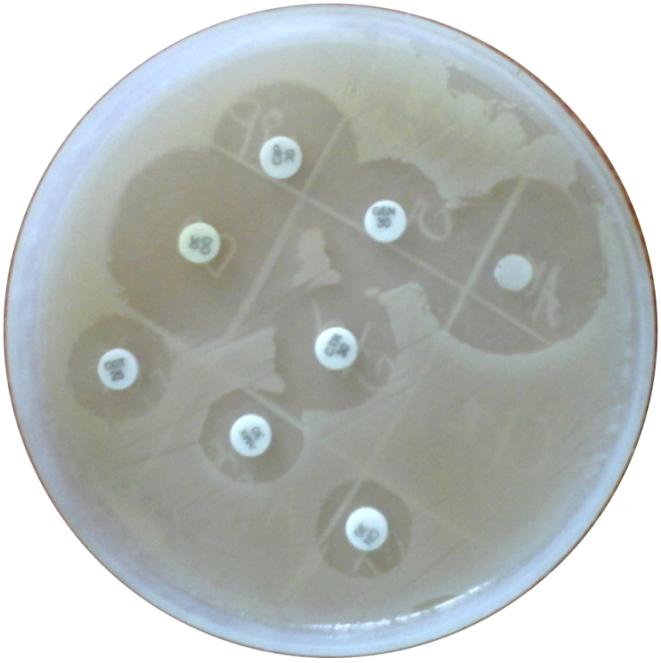


Fig 4: Antibiotic Sensitivity Pattern of Staphylococcus aureus

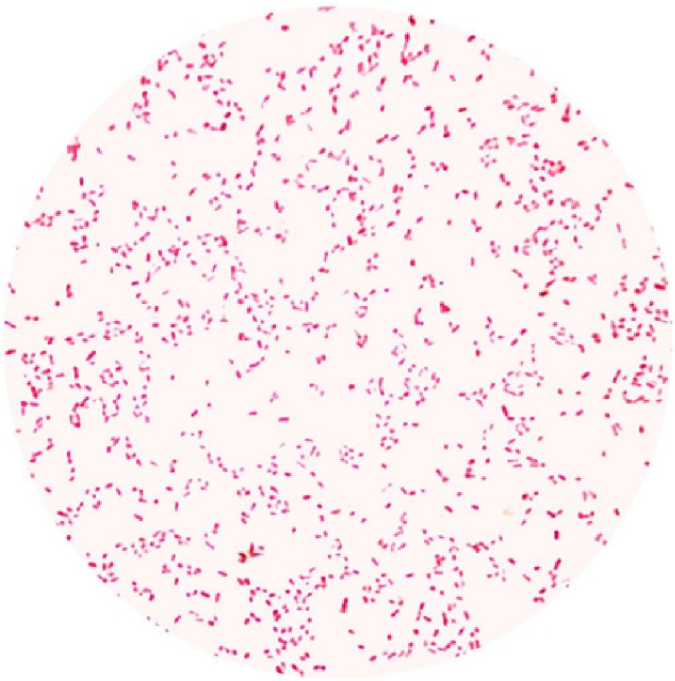


Fig 5: Gram's Stain Showing Gram negative bacilli in discrete arrangement

Fig 6: Colonies of Klebsiella pneumoniae on MacConkey agar plate

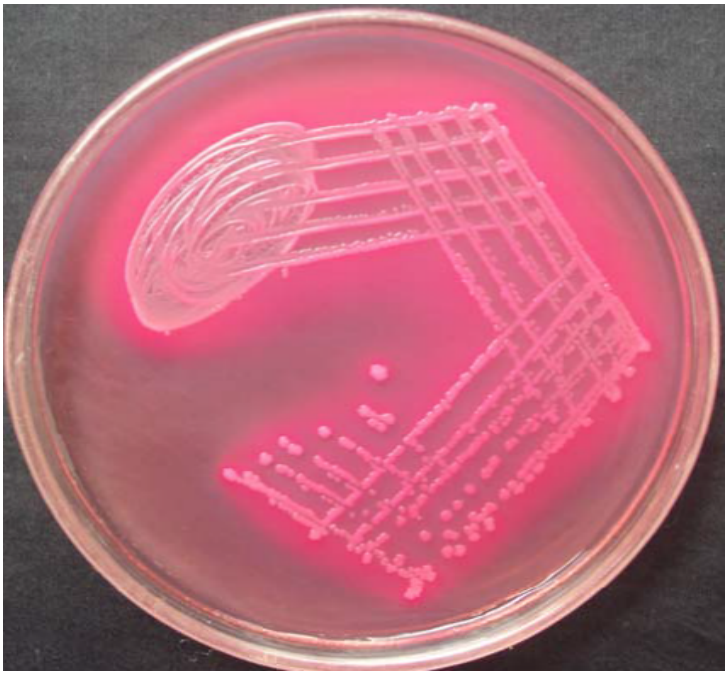


Fig 7: Colonies of E.coli on MacConkey agar plate

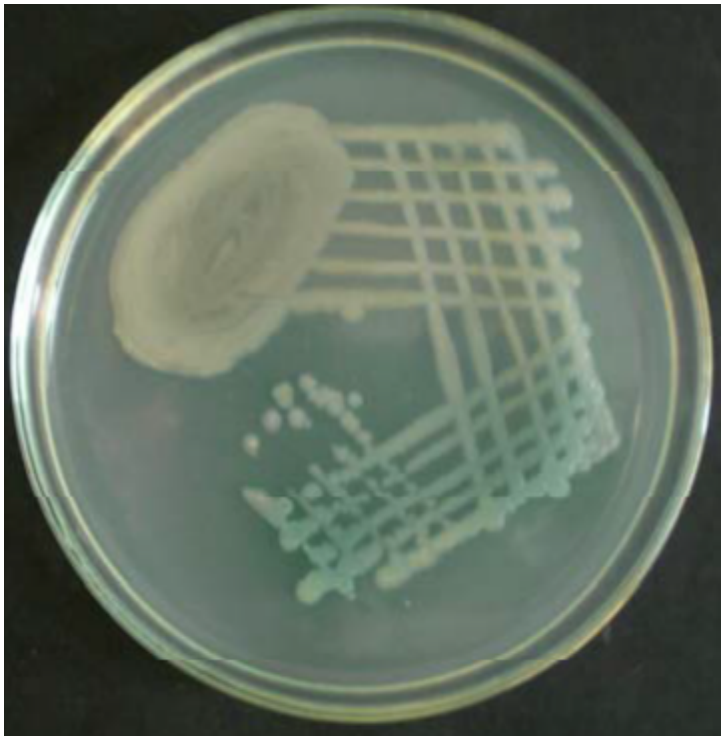


Fig 8: Colonies of pseudomonas aeruginosa on nutrient agar plate

Fig 9: Biochemical Reaction of E.coli

Fig 10: Antibiotic Sensitivity Pattern of E.coli

RESULTS

RESULTS AND ANALYSIS

In the present study 220 clinically diagnosed case of SSIs were studied for a period of one year (August 2013 to July 2014) in all ages and both sexes

AGE AND SEX DISTRIBUTION OF PATIENTS WITH SSI

Table no:1 Age distribution of patient with SSIs

Sl. No.	Age group in years	Male		Female		Total	
		No	%	No	%	No	%
1	11-20	9	69.2	4	30.8	13	5.9
2	21-30	22	41.5	31	58.5	53	24.1
3	31-40	33	67.3	16	32.7	49	22.3
4	41-50	35	68.6	16	31.4	51	23.2
5	51-60	18	66.7	9	33.3	27	12.3
6	61-70	14	73.7	5	26.3	19	8.6
7	71 and above	6	75	2	25	8	3.6
Total		137	62.3	83	37.7	220	100

Out of 220 , clinically diagnosed cases, SSIs rate was more in 21-30 groups.

CORRELATION BETWEEN SSIs AND PRE HOSPITAL STAY

Table: 2 SSIs and pre hospital stay

S.NO	PRE OPERATIVE STAY	SURGICAL SITE INFECTIONS	PERCENTAGE
1	0	35	15.9%
2	1	18	8.2%
3	2	62	28.2%
4	3	39	17.7%
5	4 and above	66	30%
TOTAL		220	100%

Preoperative stay of 4 and above showed high SSIs rate

SSIs IN RELATION TO POST OPERATIVE DAY OF DIAGNOSIS

Table: 3 SSIs and Post operative day of diagnosis

S.NO	POST OPERATIVE DAY	SURGICAL SITE INFECTIONS	PERCENTAGE
1	1	0	0%
2	2	0	0%
3	3	13	5.9%
4	4	37	16.8%
5	5	59	26.8%
6	6	44	20.0%
7	7 and above	67	30.5%
TOTAL		**220**	**100%**

SSIs were more after 1 week of surgery

DISTRIBUTION OF SSIs IN VARIOUS SURGICAL UNITS

Table no: 4 Distribution of SSIs in various surgical units

S NO	Surgical units	Infected cases	Percentage
1	Surgery	85	38.6%
2	Obstetrics and Gynaecology	45	20.5%
3	Orthopedics	90	40.9%
Total		220	100%

P value: 0.00

Out of 220 cases, 45 were Obstetrics cases and organism isolated in 40% cases and 85 cases were General surgery cases and organism isolated in 72.9% cases and Obstetric cases includes 90 of which organisms isolated in 81.1% cases.

SSIS ACCORDING TO VARIOUS CLASS OF WOUND

Table no: 5 SSIs in relation to VARIOUS class of wound

Sl. No.	Class Of Wound	Infected	Percentage
1	I	20	9.1%
2	II	71	32.3%
3	III	110	50%
4	IV	19	8.6%
Total		220	100%

P value: < 0.05

Out of 220 cases, 20 cases were Clean wound, 71 were Clean contaminated, 110 were contaminated wound and 19 were dirty wound.

With infection rate is more in Contaminated wound.

SSI IN RELATION TO TYPE OF SURGERY

Table no:6 SSIs in relation to type of surgery

Sl. No.	Type of surgery	Infected	Percentage
1	Elective	98	44.5%
2	Emergency	122	55.5%
Total		220	100%

P value: 0.01

Out of 220 cases, Elective cases were 98 and Emergency cases were 122 with infection rate is more in Emergency cases.

TOTAL CULTURE POSITIVE CASES AMONG THE BACTERIAL ISOLATES

Table no:7 Total culture positive cases among bacterial isolates

Sl. No.	Culture Growth	No of cases	Percentage
1	Positive	153	69.5%
2	Negative	67	30.5%
Total Cases		220	100%

Out of 220 cases, Culture Positive were 153 and Culture negative were 67.

AEROBIC AND ANAEROBIC BACTERIAL ISOLATES AMONG CULTURE POSITIVE CASES

Table no:8 Culture positive cases and aerobic and anaerobic bacterial solates

Sl. No.	Bacterial isolates	Number of Culture positive cases	Percentage
1	Aerobic	146	95.4%
2	Anaerobic	7	4.6%
Total cases		153	100%

Out of 153 Culture positive cases, 146 were Aerobic isolates and 7 were Anaerobic isolates.

CORRELATION BETWEEN CULTURE POSITIVE CASES AND TYPE OF ORGANISMS

Table no:9 Culture positive cases and types of organisms

Sl. No.	Types of Organisms	Number of Culture positive cases	Percentage
1	Monomicrobial	134	87.6%
2	Polymicrobial	19	12.4%
Total cases		153	100%

Out of 153 Culture positive cases, 134 were Monomicrobial and 19 were Polymicrobial.

CORRELATION BETWEEN BACTERIAL ISOLATES AND INFECTED CASES IN VARIOUS SURGICAL UNITS

Table no:10 Infected cases and bacterial isolates

SNO	Surgical units	Cases NO (%)	Aerobic Bacterial isolates		TOTAL	Anaerobic Bacterial isolates		TOTAL	Total no of isolates NO (%)
			Gram positive NO(%)	Gram negative NO (%)		Gram positive NO(%)	Gram negative NO(%)		
1	Surgery	85(38.6)	15(22.7)	51(77.2)	66(39.8)		4(100)	4(57.1)	68(39.3)
2	Obstetrics and Gynaecology	45(20.5)	10(55.6)	8(44.4)	18(10.8)	-	-	-	18(10.4)
3	Orthopedics	90(40.9)	24(29.3)	58(70.7)	82(49.4)	2(66.7)	1(33.3)	3(42.9)	87(50.3)
4	TOTAL	220	49(29.5)	117(70.5)	166(96)	2(28.6)	5(71.4)	7(4)	173(100)

SPECTRUM OF BACTERIAL ISOLATES IN DIFFERENT SURGICAL UNITS

Table no:11 Bacterial isolates in different surgical units

S NO	Aerobic Bacterial isolates	Surgical units			Total
		Surgery ward	Obstetrics and Gynaecology ward	Orthopedic ward	
1	Staphylococcus aureus	**12**	**7**	**22**	**41**
2	Klebsiella pneumoniae	**18**	**4**	**17**	**39**
3	Escherichia coli	**18**	**1**	**10**	**29**
4	Pseudomonas aeruginosa	**3**	**3**	**19**	**25**
5	Proteus mirabilis	**4**		**9**	**13**
6	Staphylococcus epidermidis	**2**	**3**	**2**	**7**
7	Klebsiella oxytoca	**4**		**2**	**6**
8	Acinetobacter baumannii	**3**			**3**
9	Citrobacter freundii	**1**		**1**	**2**
10	Enterococcus faecalis	**1**			**1**
	Anaerobic Bacterial isolates				
1	Anaerobic bacilli	**4**		**1**	**5**
2	Anaerobic cocci			**2**	**2**
Total		**70**	**18**	**85**	**173**

DISTRIBUTION OF CULTURE POSITIVE CASES AND AEROBIC AEROBIC GRAM NEGATIVE ORGANISMS IN PATIENTS WITH SSIs

Table no:12 aerobic gram negative isolates

Sl. No.	Gram negative isolates	Total No	Percentage
1	Klebsiella pneumoniae	39	33.3%
2	Escherichia coli	29	24.8%
3	Pseudomonas aeruginosa	25	21.4%
4	Proteus mirabilis	13	11.1%
5	Klebsiella oxytoca	6	5.1%
6	Acinetobacter baumannii	3	2.6%
7	Citrobacter freundii	2	1.7%
Total		117	100%

DISTRIBUTION OF AEROBIC GRAM POSITIVE ORGANISMS IN PATIENTS WITH SSIs

Table no: 13 Distribution of aerobic Gram positive isolates

Sl. No.	Gram positive isolates	Total No	Percentage
1	Staphylococcus aureus	41	83.7%
2	Staphylococcus epidermidis	7	14.3%
3	Enterococcus faecalis	1	2%
Total		49	100%

CULTURE POSITIVE CASES AND ANAEROBIC BACTERIAL ISOLATES

Table no : 14 Culture positive cases and anaerobic isolates

Sl. No.	Anaerobic isolates	Total No	Percentage
1	Anaerobic bacill	5	71.4%
2	Anaerobic cocci	2	28.6%
Total		7	100%

SPECTRUM OF ORGANISMS ISOLATED FROM DIFFERENT CLASSES OF WOUNDS

Table no: 15 Spectrum of organisms isolated from different classes of wounds

Class of wound	Total no of culture positive cases	Staphylococcus aureus	Klebsiella pneumoniae	Escheichia coli	Pseudomonas aeruginosa	Proteus mirabilis	Staphylococcus epidermidis	Klebsiella oxytoca	Anaerobic bacilli	Acinetobacter baumannii	Anaerobic cocci	Citrobacter freundii	Enterococcus faecalis	Total no of 0rganisms	Percentage
I	5	3 (60%)	0	1 (20%)	0	0	1 (20%)	0	0	0	0	0	0	5	2.9%
II	39	15 (37.5%)	8 (20%)	5 (12.5%)	5 (12.5%)	1 (2.5%)	4 (10%)	2 (5%)	0	0	0	0	0	40	23.1%
III	92	21 (19.6%)	24 (22.4%)	19 (17.8%)	20 (18.7%)	11 (10.3%)	2 (1.9%)	3 (2.8%)	2 (1.9%)	2 (1.9%)	0	2 (1.9%)	1 (0.9%)	107	61.9%
IV	17	2 (9.5%)	7 (33.3%)	4 (19%)	0	1 (4.8%)	0	1 (4.8%)	3 (14.3%)	1 (4.8%)	2 (9.5%)	0	0	21	12.1%
Total	153	41 (23.7%)	39 (22.5%)	29 (16.8%)	25 (14.4%)	13 (7.5%)	7 (4%)	6 (3.5%)	5 (2.9%)	3 (1.7%)	2 (1.2%)	2 (1.2%)	1 (0.6%)	173	100%

SENSITIVITY PATTERN OF GRAM NEGATIVE ORGANISMS

Table no 16: Sensitivity pattern of Gram negative organisms

SNO	ANTIBIOTICS	ORGANISMS						
		Klebsiella pneumoniae (39)	**E.coli (29)**	**Pseudomonas aeruginosa (25)**	**Proteus Mirabilis (13)**	**Klebsiella oxytoca (6)**	**Acinetobacter baumannii (3)**	**Citrobacter freundii (2)**
1	Amikacin(AK)	29(74.4%)	29(100%)	18(72%)	9(69.2%)	6(100%)	1(33.3%)	2(100%)
2	Cefotaxime(CTX)	11(28.2%)	17(58.6%)	4(16%)	7(53.8%)	3(50%)		2(100%)
3	Ciprofloxacin(CIP)	24(61.5%)	21(72.4%)	20(80%)	8(61.5%)	5(83.3%)	3(100%)	2(100%)
4	Ofloxacin(OF)	18(46.2%)	16(55.2%)	11(44%)	7(53.8%)	4(66.7%)		2(100%)
5	Gentamycin(G)	24(61.5%)	27(93.1%)	15(60%)	9(69.2)	5(83.3%)	1(33.3%)	2(100%)
6	Cotrimoxazole(COT)	9(23.1%)	3(10.3%)	2(8%)	4(30.8)	2(33.3%)		2(100%)
7	Piperacillin Tazobactam(PIT)	39(100%)	29(100%)	25(100%)	13(100)	6(100%)	3(100%)	2(100%)
8	Amoxyclav(AMC)	9(23.1%)	5(17.2%)	16(64%)	3(23.1)	2(33.3%)		1(50%)
9	Cefoperazone Sulbactam(CFS)	39(100%)	29(100%)	25(100%)	13(100)	6(100%)	3(100%)	2(100%)
10	Tobramycin	-		21(84%)				
11	Ceftazidime(CAZ)	29(74.4%)	21(72.4%)	23(92%)	9(69.2%)	6(100%)	3(100%)	1(50%)
12	Meropenem(MRP)	39(100%)	29(100%)	24(96%)	13(100%)	6(100%)	3(100%)	2(100%)

SENSITIVITY PATTERN OF GRAM POSITIVE ORGANISMS

Table no:17 Sensitivity pattern of Gram positive organisms

SNO	ANTIBIOTICS	ORGANISMS		
		Staphylococcus Aureus (41)	Staphylococcus Epidermidis (7)	Enterococcus Faecalis(1)
1	Ampicillin(Amp)	6(14.6%)	1(14.3%)	
2	Gentamycin(G)	5(12.2%)	3(42.9%)	
3	Cotrimoxazole(COT)	21(51.2%)	3(42.9%)	1(100%)
4	Ofloxacin(OF)	5(12.2%)	3(42.9%)	
5	Doxycycline(DO)	30(73.2%)	6(85.7%)	1(100%)
6	Erythromycin(E)	33(80.5%)	6(85.7%)	1(100%)
7	Linezolid(LZ)	41(100%)	7(100%)	1(100%)
8	Vancomycin(VAN)	41(100%)	7(100%)	1(100%)
9	Amoxyclav(AMC)	17(41.5%)	5(71.4%)	
10	Cefotaxime(CTX)	14(34.1%)	2(28.6%)	
11	Ciprofloxacin(CIP)	21(51.2%)	2(28.6%)	

RESULTS

A prospective study of Bacteriological profile of Surgical site infections and their Antibiogram was conducted over a period of 1 year between August 2013 and July 2014.

220 cases operated in the Department of Surgery, Orthopedics and Obstetrics and Gynaecology were included in the study, to find out the prevalence of SSIs and its antibiotic sensitivity pattern.

AGE DISTRIBUTION OF SSI:

Age wise distribution of SSIs as shown in table 1, revealed that out of 220 clinically diagnosed cases, 13 were infected in (11-20) age group, 53 infected cases were seen in(21-30)age group, 49 cases in (31-40) age group , 51 cases were affected in (41-50)age group, 27 cases in (51-60) age group. Among the (61-70) age group, 19 infected cases seen and 8 infective cases were in (81-90) age group.

Surgical site infection was more in 21-30 age group followed by 41-50 age group.

SEX DISTRIBUTION:

As given in table 1,

Out of 220 clinically diagnosed cases, 137(62.3%) were males and 83(37.7) were females with male to female ratio 1.65:1 which shows that Males were more affected than females and it is found to be statistically significant with p value(0.004).

CORRELATIO BETWEEN SSIS AND PRE HOSPITAL STAY:

According to table 2,

Among the 220 clinically diagnosed cases, SSIs were predominant in those with prolonged pre operative stay. As given in table 2, a preoperative stay of 4 days and above showed a significant increase in the rate of SSI.

SSIS IN RELATION TO POSTOPERATIVE DAY OFDIAGNOSIS

As listed in table 3 ,

It also showed a correlation parallel to that of pre operative stay. Day 4 to day 7 and above showed, increased number of cases.

DISTRIBUTION OF SSIs IN VARIOUS SURGICAL UNITS

Of the 220 clinically diagnosed cases, 38.6% cases were General surgery cases. Obstetrics and Gynaecology cases contributed to 20.5% and 40.9% cases were from Orthopedic units .Thus more number of cases were seen in Orthopedic units as seen in table 4.

SSIS ACCORDING TO VARIOUS WOUND CLASSES

Table 5 shows that,

Among the 220 clinically diagnosed cases , Clean wounds comprised 9.1% cases. 32.3% cases were of Clean contaminated wounds. Contaminated wounds were seen in 50% cases and Dirty wounds were seen in 8.6% cases. Out of these infection rate was more in Contaminated wound (50%) with p value (< 0.05).

SSI IN RELATION TO TYPE OF SURGERY:

As shown in table 6,

Of all 220 clinically diagnosed cases, Elective surgeries were only 98(44.5%) and organism isolated in 64.% cases, where as Emergency Surgeries comprised of 122(55.5%)cases and organism isolated in 73.8% cases. SSIs were more common in Emergency than Elective cases. This association was found to be statistically significant with p value (0.01).

TOTAL CULTURE POSITIVE CASES AMONG THE BACTERIAL ISOLATES

According to table 7 , of the total 220 cases, 153(69.5%) were culture positive and 67 (30.5%) were culture negative.

AEROBIC AND ANAEROBIC BACTERIAL ISOLATES AMONG CULTURE POSITIVE CASES

As in table 8 ,among the 153 culture positive cases, 146 (95.4%) samples were positive for aerobic culture and 7(4.6%) cases for anaerobic organisms.

CORRELATION BETWEEN CULTURE POSITIVE CASES AND TYPE OF ORGANISMS

Out of 153 culture positive cases 134(86.5%) samples yielded a single organism and 19(12.5%) samples showed polymicrobial growth as shown in table 9 .

CORRELATION BETWEEN INFECTED CASES AND BACTERIAL ISOLATES IN VARIOUS SURGICAL UNITS

As given in table 10 ,

Of the 166 organisms , 15(22.7%) gram positive and 51(77.3%) gram negative organisms were isolated in 85 General surgery cases. In Obstetrics and Gynaecology surgeries 10(55.6%)

were gram positive and 8 (44.4%) were gram negative isolates among the 45 clinically diagnosed SSIs . Among the Orthopedics cases 24(29.3%) gram positive organisms and 58(70.7%) gram negative organisms were isolated .Infection due to gram negative organisms were more common in Orthopaedic and General surgery cases. Obstetrics and Gynaecology cases had a preponderance of gram positive organisms. Among the 7 anaerobic isolates, 5 (71.4%)were Gram negative anaerobic bacilli and 2(28.6%) were anaerobic Gram positive cocci.

SPECTRUM OF BACTERIAL ISOLATES IN DIFFERENT SURGICAL UNITS

According to Table 11,

Out of 166 aerobic bacterial isolates , SSIs in General surgery had more isolates of Klebsiella pneumoniae and Escherichia coli. Staphylococcus aureus infection was more common in Obstetrics and gynaecology cases. Staphylococcus aureus and Pseudomonas aeruginosa were frequently isolated from Orthopedic cases.Out of 7 anaerobic isolates 4 were from general surgery cases and 3 in Orthopedic cases. Anaerobic cocci were more common in orthopedic cases and anaerobic bacilli in general surgery cases.

CULTURE POSITIVE CASES AND GRAM NEGATIVE ORGANISMS

As listed in table12

Out of 166 aerobic organisms isolated, 117(71%) were Gram negative organisms. Among these, Klebsiella pneumoniae were more common followed by Escherichia coli 29(24.8%) and Pseudomonas aeruginosa(21.4%)

CULTURE POSITIVE CASES AND GRAM POSITIVE ORGANISMS

As given in table 13

Out of 166 aerobic organisms isolated,49(29%) were gram positive organisms and among these Staphylococcus aureus was the most common organism isolated and Staphylococcus epidermidis isolated in 7(14.3%) cases usually from LSCS and other abdominal surgeries.

Thus out of 146 aerobic culture positive cases, 166 organisms were isolated and out of these 117 were Gram negative organisms accounting for (71 %) of isolates and 49 were Gram positive organisms accounting for (29%) of isolates.

CULTURE POSITIVE CASES AND ANAEROBIC BACTERIAL ISOLATES

As given in table 14 ,out of 7 culture positive cases, 5(71.4%) were of anaerobic bacilli and 2(28.6%) were anaerobic cocci .

SPECTRUM OF ORGANISMS ISOLATED FROM DIFFERENT CLASS OF WOUND

As listed in table 15

Out of total 153 culture positive cases, 173 organisms were isolated. Out of 5 culture positive cases in clean wound, a total of 5(2.9%) organisms were isolated . In the clean contaminated wound, out of 40 culture positive cases 15(37.5%) organisms were isolated. Staphylococcus aureus 3(60%) were the predominant organism isolated in clean and clean contaminated wound. In the contaminated wound class,107(61.9%) organisms were isolated out of 92 culture positive cases. 21 (12.1%)organisms were isolated from Dirty(class IV)cases which were 17 numbers. Klebsiella pneumoniae were the predominant organisms isolated in contaminated and dirty wounds.

ANTIBIOGRAM PATTERN OF GRAM NEGATIVE ISOLATES

Table 16 also shows that, in the 117 isolates, Almost all Gram negative bacilli were 100% sensitive to Piperacillin / Tazobactam , Cefoperazone Sulbactam and Meropenem.

Klebsiella pneumoniae isolates showed sensitivity of 60-74% for Amikacin, Gentamicin,Ceftazidime and Ciprofloxacin. Sensitivity to Ofloxacin, Cefotaxime , Cotrimoxazole and Amoxyclav were relatively minimal.

Of the 29 *Escherichia coli* isolates, all showed sensitivity of 100% to Amikacin and Gentamycin apart from Piperacillin / Tazobactam , Cefoperazone Sulbactam and Meropenem.50- 70% sensitivity were seen in ciprofloxacin, cefotaxime and ofloxacin. They were almost resistant to amoxyclav and cotrimoxazole .

Among the 25 *Pseudomonas aeruginosa* isolates , 70-80% sensitivity to Tobramycin, Ciprofloxacin and Amikacin and Ceftazidimewere seen. Sensitivity to Gentamycin were around 40 % and they were least sensitive to Cotrimoxazole and Cefotaxime.

Out of 13 isolates of *Proteus mirabilis*, 9 (69.2%) were sensitive to Gentamicin, Amikacin, and Ceftazidime, 40-60% sensitivity were seen in Ciprofloxacin, Ofloxacin, and Cefotaxime.

Out of 6 *Klebsiella oxytoca* isolates, all the 6 (100%) were sensitive to Amikacin ,ceftazidime and also to three other drugs such as Piperacillin/Tazobactam , Cefoperazone Sulbactam and Meropenem. Sensitivity to Gentamicin and Ciprofloxacin were only 83.3%. whereas sensitivity to Ofloxacin and Cefotaxime was around 50-60%.

Apart from Piperacillin / Tazobactam , Cefoperazone Sulbactam and Meropenem *Acinetobacter baumannii was* sensitive to Ceftazidime and Ciprofloxacin and showed very low sensitivity to all other antibiotics.

Out of 2 *Citrobacter freundii* isolated , 50% sensitivity was for amoxyclav and Ceftazidime. Both isolates were sensitive to Gentamicin , Amikacin, Ofloxacin, Cotrimoxazole, Amoxyclav and all other antibiotics

ANTIBIOGRAM PATTERN OF GRAM POSITIVE ISOLATES

As shown in Table 17, in the 49 Gram positive isolates,

All the Gram positive bacilli showed 100% sensitivity to Linezolid and Vancomycin. Out of 49 isolates, 41 were *Staphylococcus aureus* and showed 70-80% sensitivity to Erythromycin and Doxycycline. 40-50% sensitivity was for Ciprofloxacin ,Cotrimoxazole and Amoxyclav. Least sensitivity to Cefotaxime, Ampicillin , Gentamycin and Ofloxacin was also encountered.

Of 7 *Staphylococcus epidermidis* isolates,70-80% were sensitive to Doxycycline, Erythromycin and Amoxyclav. Cotrimoxazole Gentamycin , Ofloxacin ,Ciprofloxacin and Cefotaxime showed 20-40% sensitivity.

The Only isolate of *Enterococcus faecalis*was 100%sensitive to Cotrimoxazole, Doxycycline and Erythromycin and also to Linezolid and Vancomycin as mentioned in table 16.

CHART 1: AGE AND SEX DISTRIBUTION OF PATIENTS WITH SSI

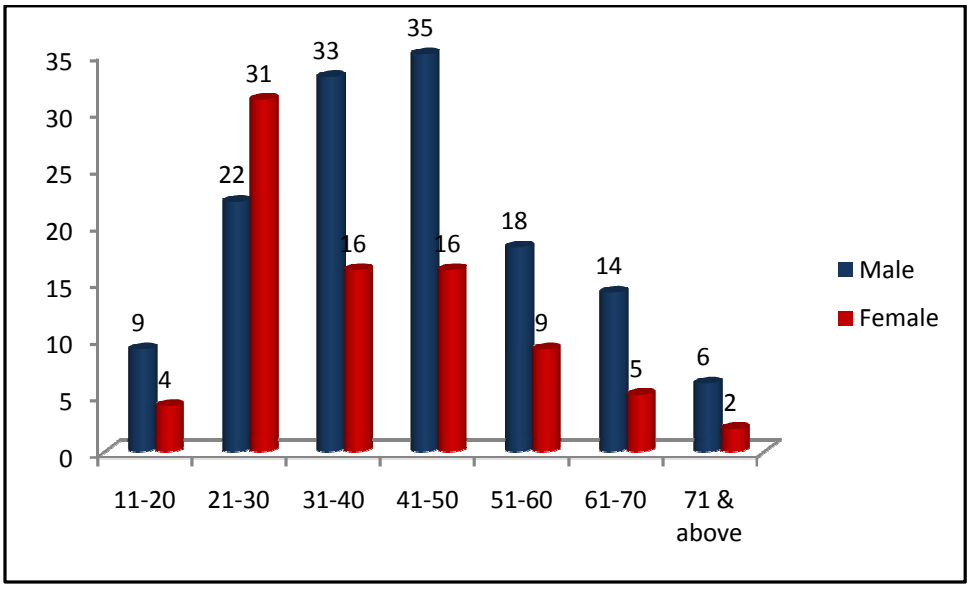


CHART 2: CORRELATION BETWEEN SSIs AND PRE HOSPITAL STAY

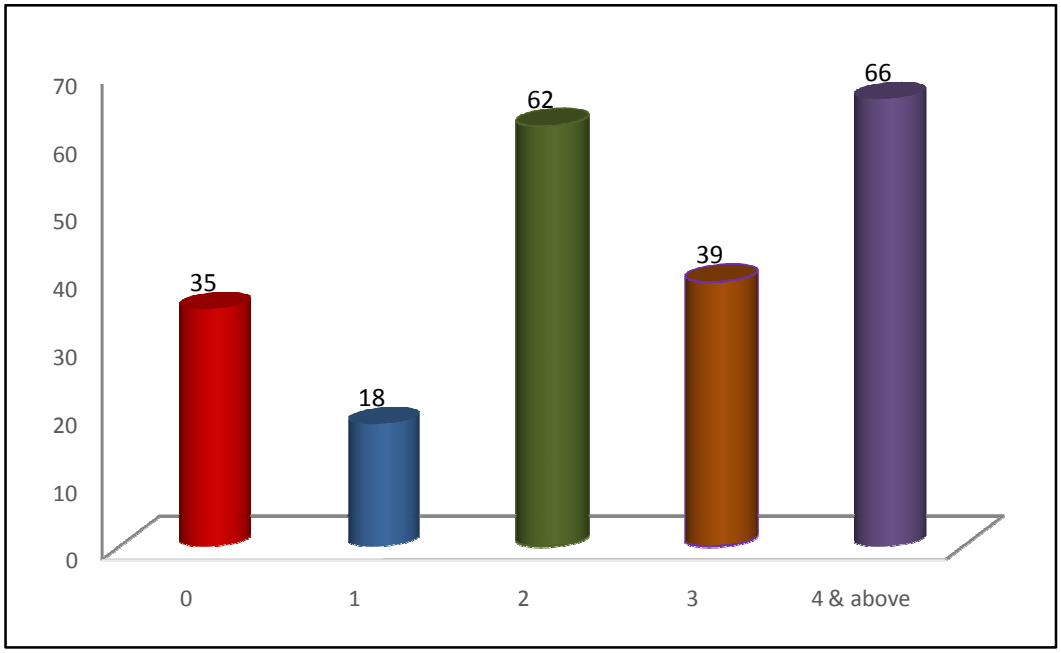


CHART 3: SSIs IN RELATION TO POST OPERATIVE DAY OF DIAGNOSIS

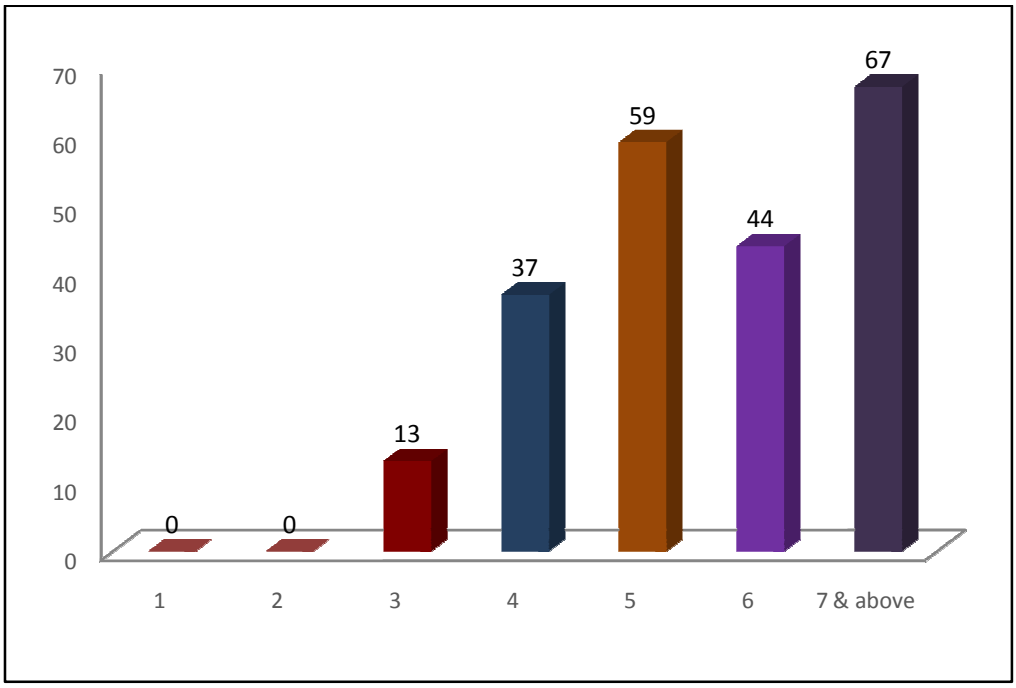


CHART 4: DISTRIBUTION OF SSIs IN VARIOUS SURGICAL UNITS

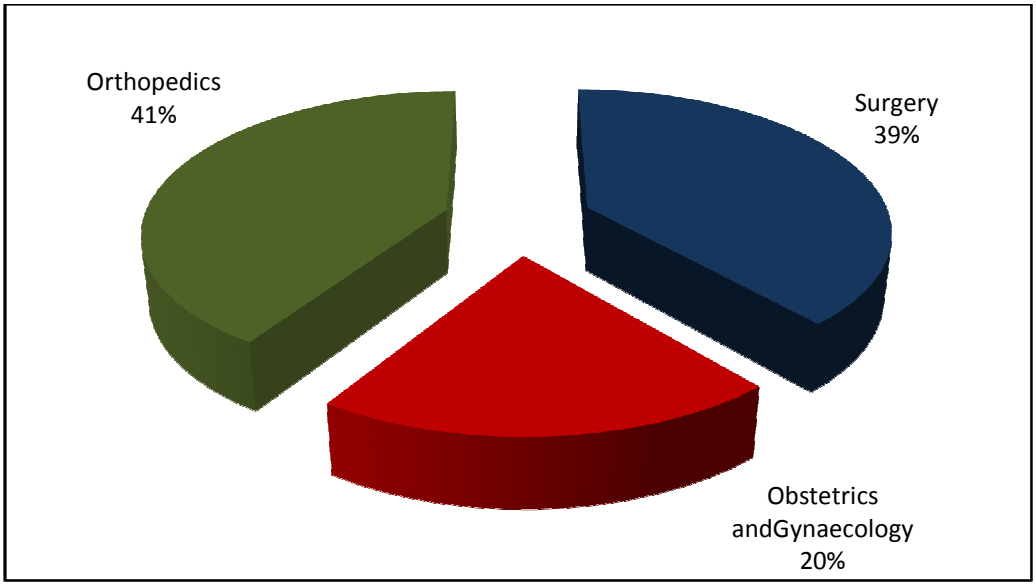


CHART 5: SSIs ACCORDING TO VARIOUS WOUND CLASSES

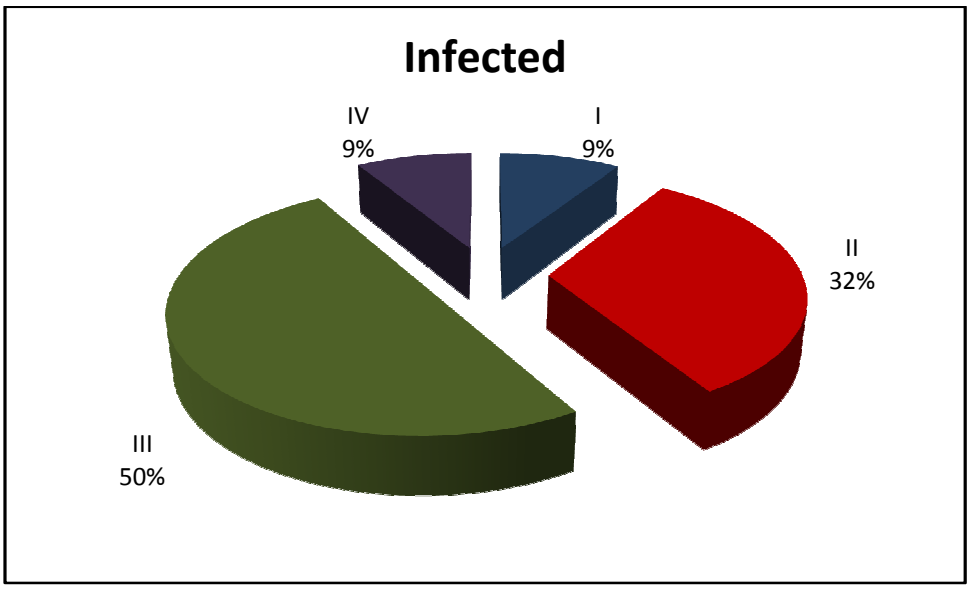


CHART 6: SSI IN RELATION TO TYPE OF SURGERY

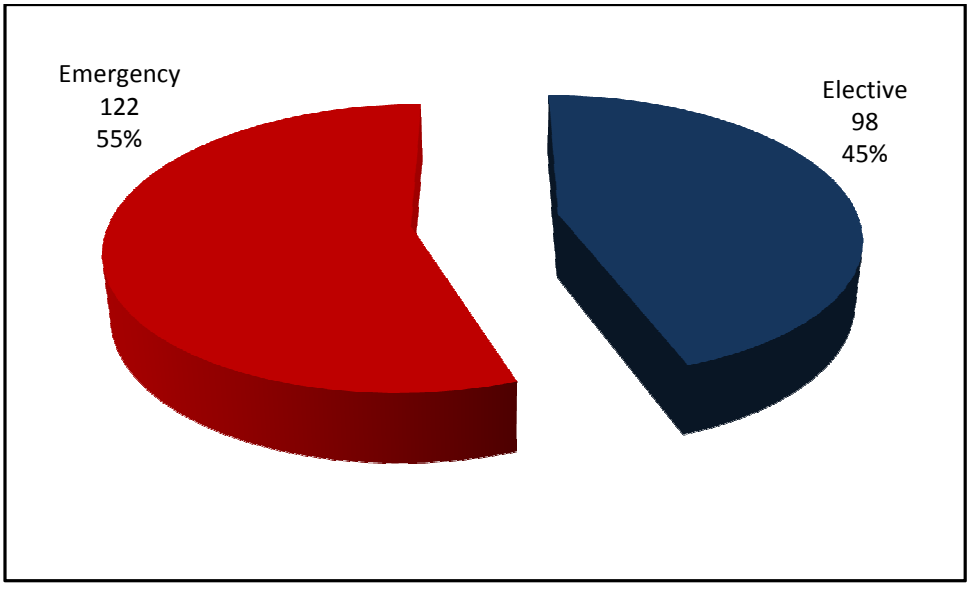


CHART 7: TOTAL CULTURE POSITIVE CASES AMONG THE BACTERIAL ISOLATES

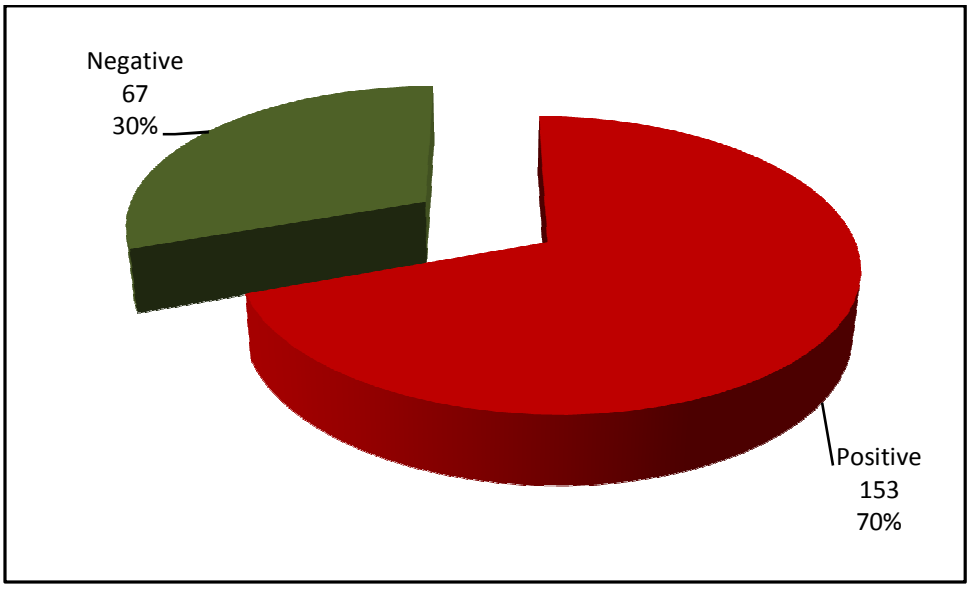


CHART 8: AEROBIC AND ANAEROBIC BACTERIAL ISOLATES AMONG CULTURE POSITIVE CASES

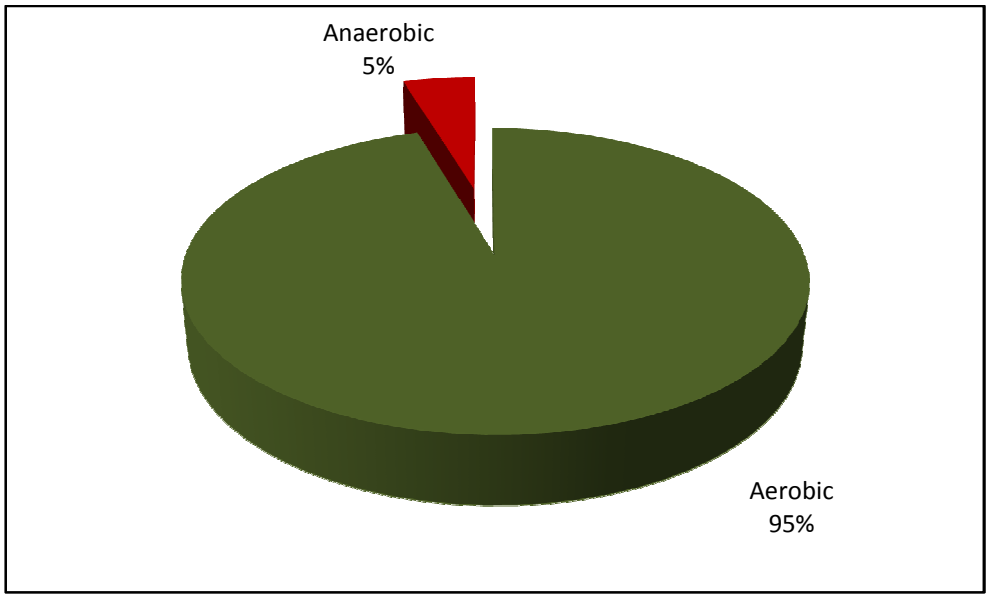


CHART 9: CORRELATION BETWEEN CULTURE POSITIVE CASES AND TYPE OF ORGANISMS

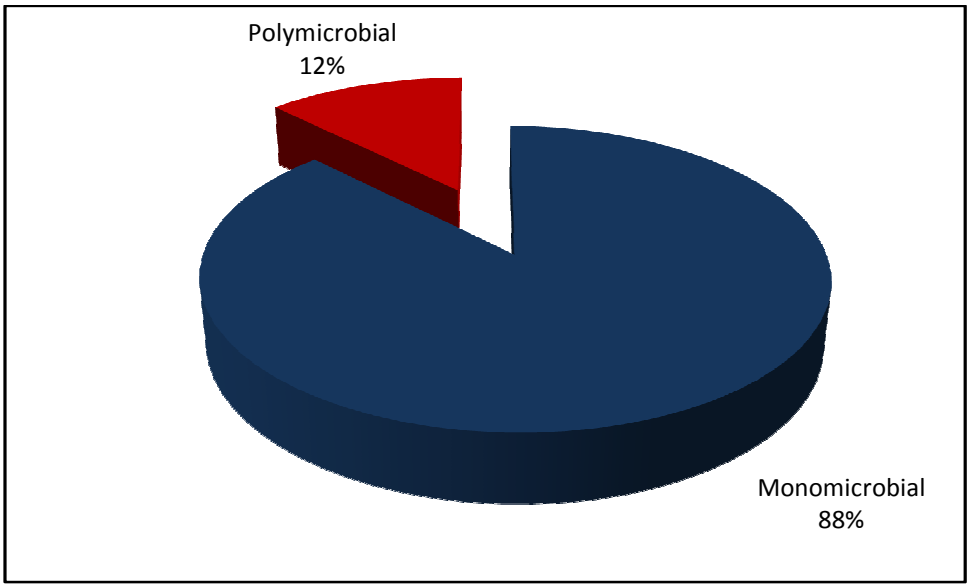
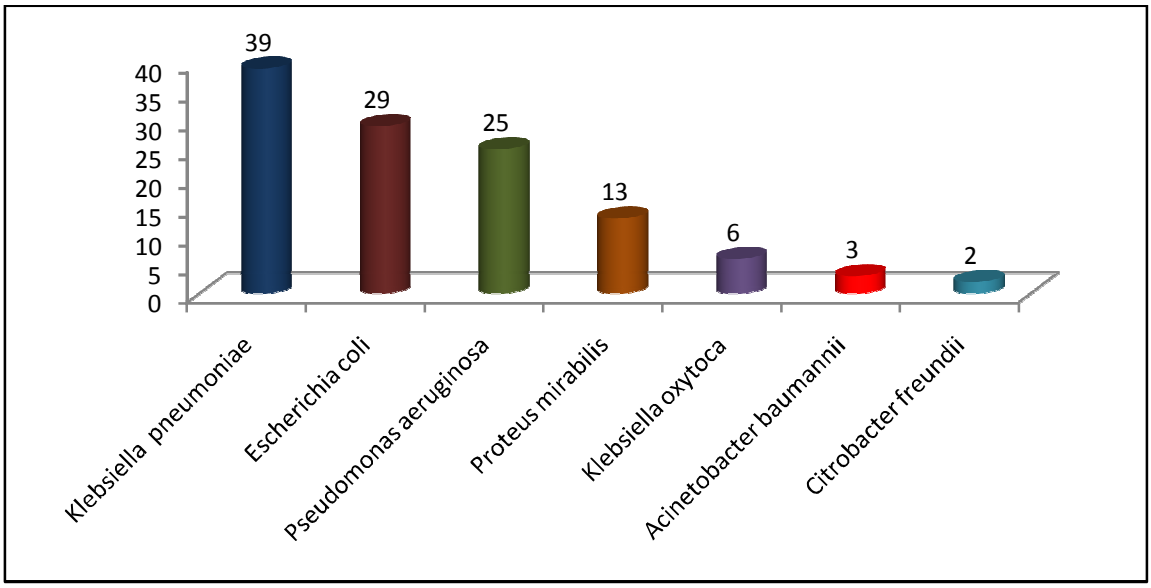


CHART 10: CULTURE POSITIVE CASES AND AEROBIC GRAM NEGATIVE ORGANISMS



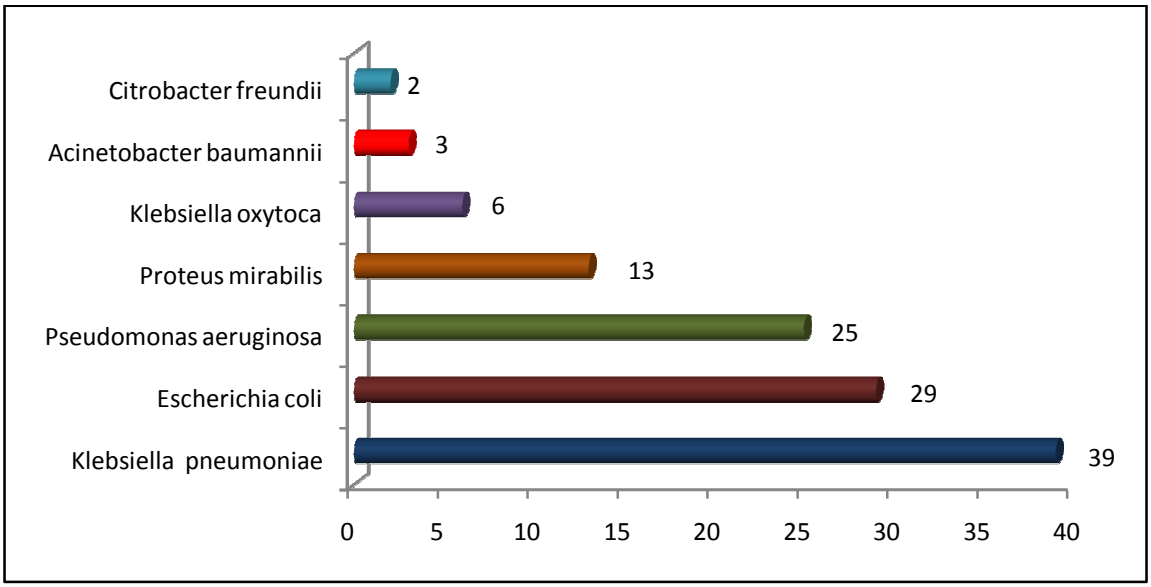


CHART 11: CULTURE POSITIVE CASES AND AEROBIC GRAM POSITIVE ORGANISMS

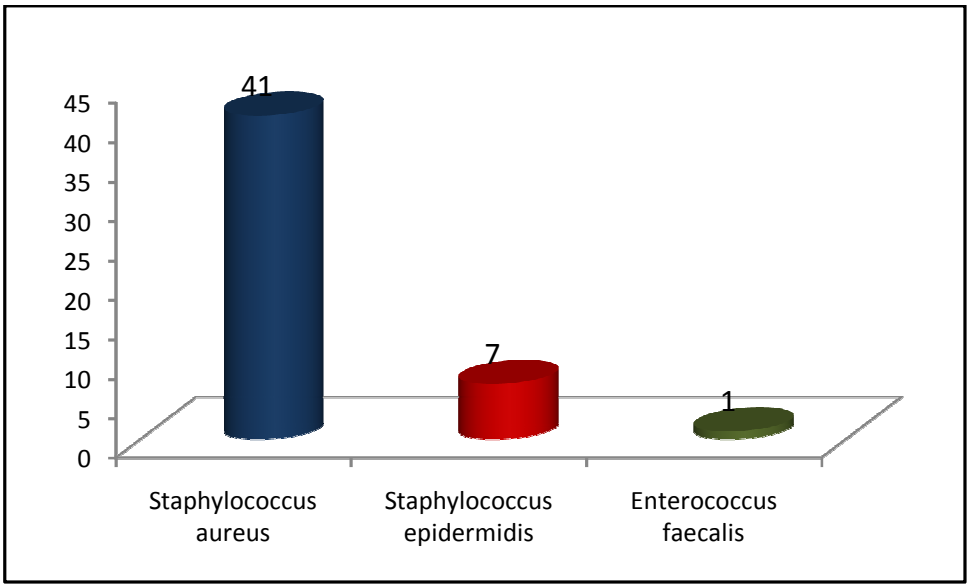
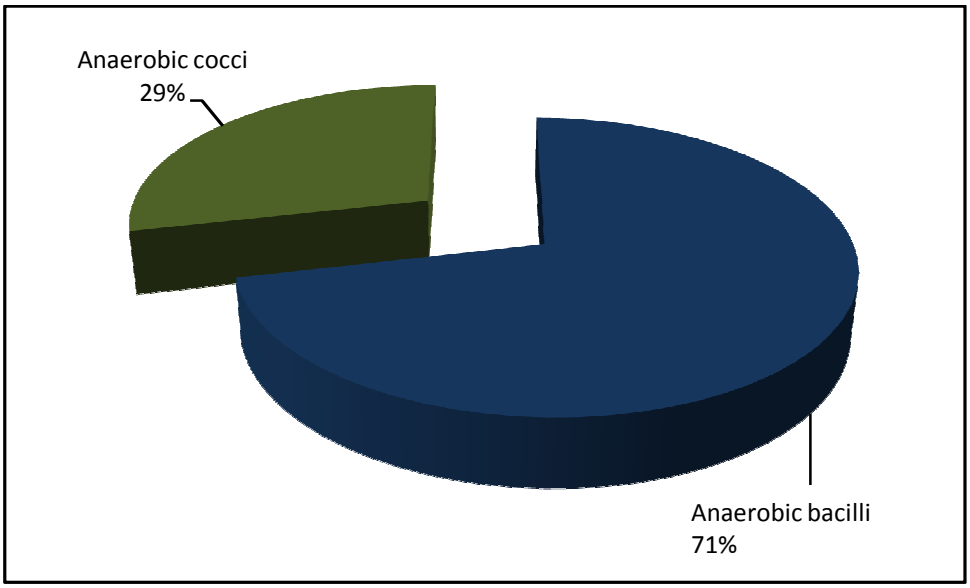


CHART 12: CULTURE POSITIVE CASES AND ANAEROBIC BACTERIAL ISOLATES



DISCUSSION

DISCUSSION

The present study was done on patients who underwent surgery in the Departments of Surgery, Orthopedics, Obstetrics and Gynaecology in Coimbatore Medical College Hospital, Coimbatore.

The total number of cases included in the study was 220, out of which 20 were clean cases, 71 were clean contaminated cases,110 were contaminated cases and 19 were dirty cases. All ages and both sexes were included in the study group.

In our study, patients were divided as 6 age groups and SSI was found to be more in 20-30 age group, comparable to that of Gayathree Naik et al., who showed high SSIs rate in 20-30 age group and it was due to more no of cases admitted for surgery in this age group. Our study is not consistent with that of Narsinga et al., Patel Sachin et al., who showed higher infection rate in patients above 50 years of age due to various factors such as malnutrition, low immunity and malabsorption, which is more common in older age groups[77,80,97].

While studying the sex distribution of SSI, it was found that out of 220 cases, 137 (62.3%) were males and 83 (37.7%) were females with infection rate more in male patients and it is found to be statistically significant with p value <0.05. This correlates with

the study conducted by Anand Saxena et al., and Masood Ahmed et al., who showed higher infection rate in male patients. This could be due to increased mobility of male patients and associated with risk factors[78].

While studying the correlation between SSI and pre-operative stay, it was found that, longer preoperative hospitalization is associated with increased incidence of wound infection ie, patients who were hospitalized for more than 5 days showed higher infection rate of 30% when compared to those of lesser stay. Similar findings have been observed by Patel et al., and PJE Cruse[80,31].

Higher incidence of infection is due to increased colonization of nosocomial strains in the hospital, poor general condition on admission , exposure to broad spectrum antibiotics and co-morbid conditions like Diabetes, UTI and other metabolic disorders and it was found that in our study, infection rate was more after 1 week of surgery which correlates with that of Chia JYH who stated that, infection rate was more after the 5th post-operative day[83].

Among the 220 cases Emergency cases (55.5%) were having higher infection rate when compared to Elective cases, which showed an infection rate of 44.5%. Higher infection in

Emergency surgery is due to combination of various factors such as poor general condition of patients, preparation time for surgery being inadequate and operation done on contaminated sites ie intestinal perforation , strangulated hernia and intestinal obstruction.

Agarwal et al., Anvikar etal., and Kamat et al., also observed increased incidence of SSIs in Emergency cases[22,85,27].

In the study of SSIs in various wound classes ,Varsha Shahane et al., noted the profound influence of wound contamination from analysis of wound categories, in which the SSIs rate in Contaminated and Clean contaminated wound was higher when compared to Clean wounds. They noted an infection rate of 12.3% in Contaminated wound,8% in Clean contaminated wound, 4.6% in Clean wound[97].

Umesh et al., noted a SSI rate of 5.4% in Clean wound, 35.5% in Clean contaminated wound and 77.8% in contaminated wound[64].

Our study showed that infection rate was 9% in Clean cases, increased to 32.3% in Clean contaminated wound and 50% in contaminated wound; Thus there was a correlation between wound infection and bacterial contamination. Possibility of contamination by skin microflora was more in clean wound and endogenous microflora in clean contaminated and contaminated wound.

SSIs rate was high in Contaminated wounds (50%) in our study, which was significant statistically and well in accordance with other studies

Colonization by human endogenous microflora was the main risk factor causing surgical site infection in contaminated wound (50%), because of more number of organisms available from the bowel and hollow visceral organs access the wound site. Also surgical techniques such as duration of surgery, suturing, vascularisation during and after surgery, etc., play a vital role in development of SSIs.

The culture results of our study showed that, Out of 220 cases 153 (69.5) were culture positive and 67 (30.5) were culture negative which correlates with that of Lilani SP study, in which out of 17 cases, 14 (82.36%)were culture positive and 3 (17.64%) were culture negative. Soleto et al., also showed 75.6% culture positivity and in the study of Gayathree Naik et al., out of 300 samples 216 (72%) were culture positive. Culture negativity may be due to prior treatment with antibiotics or the presence of fastidious organisms which do not grow on ordinary culture media[82,84].

Among the153 culture positive cases, 137 were monomicrobial and 19 were polymicrobial. In various other studies

by Kownhar H and Lilani SP, mixed organisms were isolated from 28.8%, 14.29% cases respectively.

Similar spectrum of polymicrobial organisms were isolated by Giacometti et al., in which 1060 bacterial strains were isolated from 614 individuals. A single organism was isolated in 271 patients (44.1%) and multiple organisms were isolated in 343 (55.9%) cases. Polymicrobial infections frequently involved Gram positive and Gram negative organisms with Staphylococcus aureus and Pseudomonas aeruginosa being the most common association in 53 (15.7%) cases. Apart from a few anaerobic isolates. Human endogenous flora contaminating the wound frequently causes polymicrobial infection[92].

In our study commonest association was between Klebsiella pneumoniae and Pseudomonas aeruginosa 6(31.6%).

In the 153 culture positive cases, 146 (95.4%) were aerobic isolates and 7(4.6%) were anaerobic isolates. The increase in infection due to aerobic isolates correlates with the study by Ravindra Jadeja who showed a higher infection rate with aerobic organisms when compared to anaerobic organisms[90].

Mixed infection involving aerobic and anaerobic organisms were more frequent after operative procedure excluding clean surgical procedure and also in emergency cases of traumatic etiology.

Of the 153 culture positive cases, 146 were aerobic isolates and the commonest organism was staphylococcus aureus 41 (24.7%), followed by Klebsiella pneumoniae 39 (23.5%),Escherichia coli 29 (17.5%), Pseudomonas aeruginosa 25 (15.1%), Proteus mirabilis 13 (7.8%), Staphylococcus epidermidis 7 (4.2%), Klebsiella oxytoca 6 (3.6%),Acinetobacter baumannii 3 (1.8%), Citrobacter freundii 2 (1.2%) and Enterococcus fecalis 1 (0.6%).

In the present study ,predominance of Staphylococcus aureus in SSIs is consistent with report from other studies. Lilani et al., and Chia JYH reported that Staphylococcus aureus was the common organism isolated from post operative wound infection. Garibaldi richard et al., Jido et al., and Giacometti et al., also reported similar findings[24,83,87,88,92].

On the whole, Gram negative bacilli were the predominant organisms isolated (117 isolates)70.5%. Among the Gram negative bacilli,Klebsiella pneumoniae were the most commonly isolated organisms.

In the study conducted by Anvikar et al., Klebsiella pneumoniae (26.8%) and Staphylococcus aureus (25 %) were the two most common organisms isolated which is in accordance with our study[85].

While studying the SSI in various units it was found that SSI rate was more in Orthopedic units 90(40.9%), when compared to General surgery 85 (38.6%) and Obstetric & Gynaecology units 45 (20.5%).

Staphylococus aureus was the most common organism isolated in Orthopedic cases. Surgery for open fractures were done for most of the cases and source of contamination could be due to microorganisms from external environment coupled with the presence of devitalized tissue and foreign material at the wound site. This study correlates with that of Gayathree Naik et al., who showed high rate of Staphylococcus aureus infection in Orthopedic cases[84].

Klebsiella pneumoniae and Escherichia coli being the common organisms isolated from General surgery cases is consistent with the study conducted by Brian Mawalla et al., This could be due to laparotomy surgery done for most of the cases and possible source could be colonization of Enterobacteriacea in the bowel and intestines[94].

In the Obstetric and Gynaecology cases SSIs were 20.5% and Emergency LSCS were done for most of the cases and staphylococcus aureus being the common organism isolated, which correlates with the study of Anand saxena et al.,[86].

In the present study, out of 153 culture positive cases, 7 anaerobes were isolated of which 5 were anaerobic bacilli and 2 were anaerobic cocci. Identification of anaerobic bacterial isolates from various clinical specimens was studied based upon morphological characters in Gram staining, since it required more turnaround time for culture, identification and antibiotic sensitivity testing.

Though bacteroides and peptostreptococcus were the most common anaerobic organisms isolated in post operative wound infection, in a study by Ravendra Jadeja, identification to genus and species level could not be done because of limited resources available in our laboratory set up[90].

The Antibiotic sensitivity pattern of isolated organisms were as follows;

Staphylococcus aureus (41) was 100% sensitive to Linezolid and Vancomycin, 80.5% sensitive to Erythromycin, 73.2% to Doxycycline, 51.2% sensitive to Ciprofloxacin and Cotrimoxazole,

41.5% sensitive to Amoxyclav and almost resistant to Gentamycin and Ofloxacin, Ampicillin and Cefotaxime.

Klebsiella pneumonia (39) was 100 % sensitive to Piperazillin tazobactam, Cefoperazone sulbactam and Meropenem. 74.4% to Ceftazidime and Amikacin, 61.5% sensitive to Ciprofloxacin, and Gentamycin, 46.2% sensitive to ofloxacin and 20-30% sensitive to Cefotaxime, Amoxyclav and Cotrimoxazole.

Escherichia coli (29) was 100% sensitive to Piperazillin tazobactam, Cefoperazone sulbactam, Meropenem and Amikacin, 93.1% sensitive to Gentamycin, 72.4% sensitive to ciprofloxacin and Ceftazidime, 50-60% sensitive to Gentamycin, Cefotaxime and Ofloxacin and resistant to Amoxyclav and cotrimoxazole.

Pseudomonas aeruginosa (25) was 100% sensitive to Piperazillin tazobactam, Cefoperazone sulbactam, 90-96% to Meropenem and Ceftazidime, 60-85% to Gentamycin, Ciprofloxacin, Tobramycin and Amoxyclav, 44% sensitive to Ofloxacin and least sensitive to Cefotaxime and Cotrimoxazole.

Proteus mirabilis(13) was 100% sensitive to Piperazillin tazobactam, Cefoperazone sulbactam and Meropenem. 60-70% to Gentamycin , Ciprofloxacin, Ceftazidime and Amikacin, 53.8% sensitive to Cefotaxime and Ofloxacin.

Staphylococcus epidermidis (7) was 100 % sensitive to Linezolid and Vancomycin, 85.7% sensitive to Doxycycline and Erythromycin, 42.9% sensitive to Gentamycin, Cotrimoxazole and Ofloxacin.

Klebsiella oxytoca (6) was 100% sensitive to Piperazillin tazobactam, Cefoperazone sulbactam and Meropenem, 83.3% sensitive to Ciprofloxacin and Gentamycin ,66.7 % to Ofloxacin, 50% sensitive to Cefotaxime.

Acinetobacter baumannii (3) was 100% sensitive to Piperazillin tazobactam, Cefoperazone sulbactam and Meropenem and resistant to other antibiotics.

Citrobacter freundii (2) was 100% sensitive to Piperazillin tazobactam, Cefoperazone sulbactam, Meropenem, Cefotaxime, Ciprofloxacin, Ofloxacin and Cotrimoxazole and 50 % sensitive to Ceftazidime and Amoxyclav.

Enterococcus was highly sensitive to Linezolid, Vancomycin and also to Cotrimoxazole, Doxycycline and Erythromycin.

Thus Gram positive organisms are highly sensitive to Linezolid and Vancomycin and Gram negative organisms to piperacillin tazobactam and cefoperazone sulbactam and Meropenem.

SUMMARY

SUMMARY

The present study was carried out in the Department of Microbiology, Coimbatore Medical College, for a period of one year from August 2013 to July 2014.

- A total of 220 clinically diagnosed case of SSIs were studied in all age groups and both sexes irrespective of preoperative administration of antibiotics in patients, who had undergone surgery in the Departments of Surgery, Orthopaedics and Obstetrics and Gynaecology.
- SSIs were higher in 21-30 age group.
- The difference in SSIs rate between males and females was statistically significant.
- Prolonged pre operative stay were associated with higher SSI rate.
- SSI were more after the 7^{th} Post-operative day.
- Infection rate was high in Orthopedic cases when compared to Surgery, Obstetric and Gynaecology cases.
- Emergency cases were highly infected when compared to Elective cases
- SSIs were more common in contaminated and clean contaminated when compared to clean surgeries.

- Out of 220 samples cultured, 153 samples yielded growth and 67 samples yielded no growth .
- Among the 153 culture positive cases, 146 were positive for aerobic culture and 7 were positive for anaerobic culture.
- In 153 culture positive samples, 134 samples yielded single organism and 19 samples yielded more than one organism.
- There were 166 aerobic isolates together out of 146 culture positive cases. Staphylococcus aureus was the most common gram positive organisms isolated and klebsiella pneumoniae was the most common gram negative organisms isolated.
- Among the 7 anaerobic culture positive cases, anaerobic bacilli were more common.
- The gram negative organisms were most sensitive to piperacillin tazobactam (100%), cefoperazone sulbactam followed by ceftazidime, amikacin and meropenem. The least sensitive antibiotic against gram negative organisms was cotrimoxazole.
- The gram positive organisms were more sensitive to linezolid (100%), vancomycin (100%) . The least sensitive being ofloxacin.

CONCLUSION

CONCLUSION

The present study was conducted among patients admitted for surgery in the departments of Surgery, Orthopaedics, Obstetrics and Gynaecology in Coimbatore medical college hospital.

This study has given us knowledge about Surgical Site Infections and their incidence in our hospital and also helped us in finding out, the Bacteriological profile of organisms causing surgical site infections and their antibiotic sensitivity pattern.

It greatly emphasized on the fact that, surgical site infections were more common in contaminated and clean contaminated surgeries than clean surgeries.

The incidence of SSIs rate is more common in Contaminated surgeries, therefore there is a need for adequate preparation in these cases.

While analyzing the risk factors for surgical site infections , it showed that there was increased rate of SSIs in patients who had longer pre-operative hospital stay, longer duration of surgery, emergency surgeries and in older age groups.

It was also found that post operative stay was longer in patients with SSIs when compared to those without SSIs.

Among the Culture positive cases,Staphylococcus aureus was the most common Gram positive organism isolated and Klebsiella pneumoniae was the most common Gram negative organism isolated.

Most of the Gram positive organisms were sensitive to Linezolid and Vancomycin and most of the Gram negative organisms were sensitive to Piperacillin Tazobactam and Cefaperazone sulbactam.

Inappropiate and misuse of antibiotics can cause resistance to commonly used antibiotics.Thus usage of antibiotics should be based on local and current trends on prevalent pathogens and its sensitivity pattern. By studying the bacteriological profile and its sensitivity pattern we can guide the surgeons in treatment and prophylaxis of SSIs.

Colonisation of Wound with pathogenic, frequently polymicrobial organisms leads to delayed wound healing, thereby resulting in prolonged hospitalization and increased financial burden on the Institution.

Thus post-operative wound infection rate can be reduced to a minimum level by adapting aseptic and antiseptic measures and proper antibiotic policy is a must for each institution.

Hospital Infection Control Committee plays a major role in a preventing NOSOCOMIAL INFECTIONS of which, SSI forms a part among others. Proper infection control measures and antibiotic policies should be implemented and monitored by the HICC in order to prevent the emergence of Antibiotic Resistant Strains which is an emerging global challenge of enormous proportion.

The Chennai Declaration adopted by CIDSCON on 24th August underlines the existence of 'superbugs' attributed to, indiscriminate use and over the counter sale of antibiotics. This emphasizes the need for adapting an Implementable Antibiotic Policy at the national and institutional level thereby, curbing irrational use of antibiotics and emergence of resistant strains.

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ANNEXURES

LIST OF TABLES

LIST OF CHARTS

LIST OF COLOUR PLATES

S.NO	COLOUR PLATES
1.	GRAM POSITIVE COCCI IN CLUSTERS IN GRAM STAIN
2.	COLONIES OF STAPHYLOCOCCUS AUREUS ON BLOOD AGAR
3.	COLONIES OF STAPHYLOCOCUS AUREUS WITH ß HEMOLYSIS ON BLOOD AGAR
4.	ANTIBIOTIC SENSITIVITY PATTERN OF STAPHYLOCOCCUS AUREUS
5.	GRAM NEGATIVE BACILLI IN DISCRETE ARRANGEMENT IN GRAM STAIN
6.	COLONIES OF KLEBSIELLA PNEUMONIAE ON MACCONKEY AGAR PLATE
7.	COLONIES OF ESCHERICHIA COLI ON MACCONKEY AGAR PLATE
8.	COLONIES OF PSEUDOMONAS AERUGINOSA ON NUTRIENT AGAR PLATE
9.	BIOCHEMICAL REACTION OF ESCHERICHIA COLI
10	ANTIBOTIC SENSITIVITY PATTERN OF ESCHERICHIA COLI

LIST OF ABBREVIATIONS

SSIs	- Surgical Site Infections
BAP	- Blood Agar Plate
MAC	- MacConkey Agar Plate
MSA	- Mannitol Salt Agar
RCM	- Robertson Cooked Meat Media
KIA	- Kligler Iron Agar
CoNS	- Coagulase Negative Staphylococcus
E.coli	- Escherichia Coli
LSCS	- Lower Segment Cesarian Section
RTA	- Road Traffic Accident
UTI	- Urinary Tract Infections
CTX	- Cefotaxime

PROFORMA

Name: Ip/Op no

Age: DOA:

Sex: DOS::

Ward : DOD:

Occupation:

Address:

Duration of pre-operative stay in the hospital:

Clinical history:

Clinical diagnosis:

Type of surgery:

Duration of surgery:

Past history:

Personal history:

Day of diagnosis of infection:

Type of discharge: serous/ serosanguinous/ purulent

Date of Collection of specimen:

Laboratory findings:

1. Direct smear Gram stain:
2. Culture

Biochemical tests:

Antibiotic sensitivity pattern by Kirby Bauer Disc Diffusion method according to CLSI guide lines:

CONSENT FORM

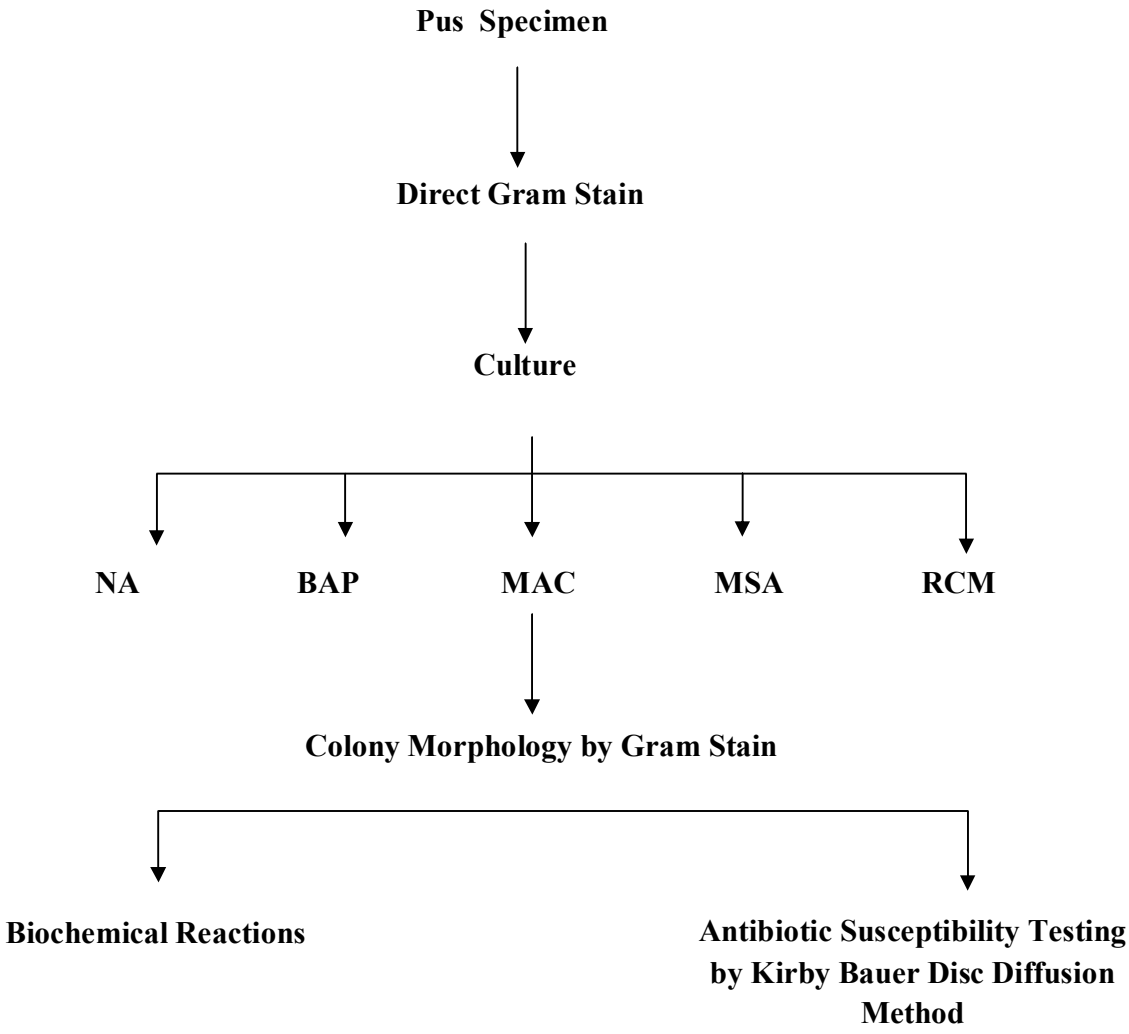
Dr.DB.Shanthi, PG student in Department of Microbiology, Coimbatore Medical College, Coimbatore, is doing a study on **"Bacteriological profile of surgical site infection and antibiotic susceptibility pattern in tertiary care hospital**" This study is based upon culture and sensitivity of pus samples collected from the patients.

It has been explained to me in my mother tongue and I hereby give my consent to collect the sample from me and to participate in this study. The data obtained may be used for research and other publication purpose.

Date:

Signature and Name of patient/Legal guardian

WORK SHEET


Pus Specimen
Direct Gram Stain
Culture
NA
BAP
MAC
MSA
RCM
Colony Morphology by Gram Stain
Biochemical Reactions
Antibiotic Susceptibility Testing by Kirby Bauer Disc Diffusion Method

MASTER CHART

MASTER CHART

S.No	NAME	AGE	SEX	WARD	DIAGNOSIS	Preop	Postc	TYPE_OF_SURGERY	WOUND	SURGERY	ORGANISM	Ak	G	CIP	OF	CTX	COT	PIT	AMC	CFS	
1	Subramani	67	Male	Surgery	Duodenal ulcer perforation with peritonitis	0	8	Emergency	Dirty	Laparotom	E.coli	S	S					S		S	
2	Ragupathy	34	Male	Surgery	Intussusception	0	7	Emergency	Clean Cont	Emergency	Klebsiella p	S	S					S		S	
3	Ayyasamy	60	Male	Surgery	Indirect inguinal hernia	1	3	Elective	Clean	Hernia repa	NG										
4	Palanismy	46	Male	Surgery	Duodenal ulcer perforation with peritonitis	0	9	Emergency	Dirty	Laparotmy	E.coli	S						S			
5	Annammal	38	Female	OG	Previous LSCS	3	3	Elective	Clean	LSCS	NG										
6	Jayaraman	65	Male	Orthopaed	Blunt injury with fracture	1	6	Elective	Clean	Closed red	NG										
7	Selvaraj	42	Male	Surgery	Acute small bowel obstruction with ileal gangrene	0	7	Emergency	Contamina	Rt hemicol	E.coli	S	S	S	S					S	
8	Rani	55	Female	Surgery	appendicular abscess perforation with peritonitis	0	9	Emergency	Dirty	Emergency	NG										
9	Vijaykumar	63	Male	Surgery	Ca sigmoid colon	2	12	Elective	Clean Cont	Total colec	E.coli	S	S					S		S	
10	Vasanthi	24	Female	OG	Primi with CPD	2	4	Elective	Clean Cont	LSCS	NG										
11	Palanismy	37	Male	Surgery	Acute intestinal obstruction	0	7	Emergency	Contamina	Emergency	Proteus mirabilis										
12	Jesina begum	24	Female	OG	Primi with fetal distress	0	4	Emergency	Clean Cont	LSCS	NG										
13	Vasantha	34	Female	OG	G2 P1 L1 A0 with obstructed labour	0	4	Emergency	Clean Cont	LSCS	CoNs								S		DO E LZ VAN
14	Malathy	41	Female	Surgery	Appendicitis	0	3	Emergency	Clean Cont	Appendice	CoNs		S						S		
15	Ragupathy	24	Male	Surgery	Appendicitis	0	3	Emergency	Clean Cont	Appendice	NG										
16	Kavitha	25	Female	OG	LSCS with fetal distress	0	4	Emergency	Clean Cont	LSCS	E.coli	S	S		S			S		S	
17	Palanisamy	37	Male	Surgery	Indirect inguinal hernia	1	3	Elective	Clean	Hernia repa	NG										
18	Duraisamy	67	Male	Surgery	Acute intestinal obstuction	0	7	Emergency	Contamina	Colostomy	E.coli			S	S			S			
19	Palraj	14	Male	Surgery	Small bowel obstuction	0	8	Emergency	Contamina	Laparotom	NG										
20	Devaraj	45	Male	Surgery	Acute intestinal obstuction	0	9	Emergency	Contamina	Colostomy	NG										
21	Jeyaprakash	17	Male	Surgery	Appendicitis	0	4	Emergency	Clean Cont	Appendice	Klebsiella p	S			S		S	S			
22	Sairabanu	27	Female	OG	G2 P1 L1 A0 with fetal distress	0	6	Emergency	Clean Cont	LSCS	Klebsiella p	S	S	S	S						
23	Ranganathan	47	Male	Surgery	Acute Small bowel obstuction	0	10	Emergency	Contamina	Small bowe	E.coli	S	S					S	S		
24	Thulasiammal	34	Female	Surgery	Incisional hernia	1	3	Elective	Clean	Hernia repa	NG										
25	Prabhu	30	Male	Surgery	Appendicitis	0	4	Emergency	Clean Cont	Appendice	NG										
26	Palanisamy	40	Male	Surgery	Gastric perforation with peritonitis	0	11	Emergency	Dirty	gastric per	NG										
27	Raju	50	Male	Surgery	Acute Small intestinal obstuction	0	6	Emergency	Contamina	Laparotom	Staph aure	S	S	S					S		LZ,VAN
28	Jijash	14	Male	Surgery	Appendicitis	0	4	Emergency	Clean Cont	Appendice	NG										
29	Saranya	21	Female	OG	Primi with PIH	2	4	Elective	Clean Cont	LSCS	NG										
30	Karupayi	50	Female	Surgery	Femoral hernia	1	3	Elective	Clean	Hernia repa	NG										
31	Mathew	39	Male	Surgery	Acute intestinal obstuction	0	8	Emergency	Contamina	Laparotom	Acinetobacter			S				S			
32	Nagarathinam	48	Female	Surgery	Appendicitis	0	4	Emergency	Clean Cont	Appendice	Pseudomo	S	S					S		S	TOB MRP
33	Revathy	24	Female	OG	Primi with failed induction	0	4	Emergency	Clean Cont	LSCS	Pseudomo	S	S	S	S			S		S	
34	Dhanalakshmi	31	Female	OG	G2 P1 L1 A0 with failed induction	0	4	Emergency	Clean Cont	LSCS	NG										
35	Nachimuthu	75	Female	Surgery	Acute intestinal obstuction	0	8	Emergency	Contamina	Laparotom	E.coli pro	S	s	S	S	S	S		s	-	
36	Vijayaprasanth	32	Male	Orthopaed	Fracture both bone rt leg	3	6	Elective	Contamina	Ext fixation	Proteus vu	S	S	S	S	S		S		S	
37	Balamurugan	35	Male	Orthopaed	Fracture both bone rt leg	2	6	Elective	Contamina	ORIF	Klebsiella pneumoniae							S		S	
38	Thulasiammal	34	Female	Surgery	Cholelithiasis	2	4	Elective	Clean Cont	Cholecyste	Klebsiella p	S	S					S		S	
39	Mathew	39	Male	Surgery	Acute intestinal obstruction	0	9	Emergency	Contamina	Emergency	Acinetobac	S		S	-		S	S	S	S	-
40	Jainab	43	Female	OG	G2 P1L1A0 with previous LSCS	2	4	Elective	Clean Cont	LSCS	CoNs	S		S					S		DO E LZ VAN
41	Duraisamy	67	Male	Surgery	Direct inguinal hernia	1	3	Elective	Clean	Hernioplas	NG										
42	Ranganathan	26	Male	Surgery	Acute appendicitis	0	6	Emergency	Clean Cont	Appendice	Staph aureus								S		DO E LZ VAN
43	Rathinam	55	Female	Surgery	Ca colon	10	21	Elective	Clean Cont	Hemicolect	Klebsiella oxytoca						S		S		
44	Duraisamy	60	Male	Surgery	Lt indirect inguinal hernia	1	3	Elective	Clean	Hernioplas	NG										
45	Subramani	53	Male	Surgery	Gastric ulcer perforation	0	11	Emergency	Dirty	Perforation	Klebsiella p	S	S		S		S		S		
46	Deepalakshmi	15	Female	Surgery	Acute appendicitis	0	6	Emergency	Clean Cont	Appendice	E.coli	S	S	S	S		S		S		

MASTER CHART

47	Nagarathinam	48	Female	Surgery	Femoral hernia	1	6	Elective	Clean	Hernia repa	NG										
48	Arulraj	44	Male	Surgery	Acute intestinal obstruction	0	9	Emergency	Contamina	Laparotom	Citrobacter	S	S	S	S	S	S	S	S	S	
49	Suppal	62	Female	Surgery	Cholelithiasis with choledocholithiasis	2	6	Elective	Clean Cont	cholecyste	Staph aure	S		S							
50	Arokiiamary	32	Female	OG	G2P1L1A0 with previous LSCS	3	6	Elective	Clean Cont	LSCS	Klebsiella p	S	S					S		S	
51	Sivagami	26	Female	OG	G2P1L1A0 with previous LSCS	3	6	Elective	Clean Cont	LSCS	NG										
52	Balachandran	22	Male	Surgery	Acute intestinal obstruction with ileal perforation	0	14	Emergency	Dirty	Laparotom	E.coli	S	S	S	S			S			
53	Sajitha banu	22	Female	OG	Primi with fetal distress	0	4	Emergency	Clean Cont	LSCS	Staph aureus					S					DO E LZ VAN
54	Sundari	21	Female	OG	Primi with failed induction	0	4	Emergency	Clean Cont	LSCS	NG										
55	Kowsalya	24	Female	OG	G2P1L1A0 with previous LSCS	3	4	Elective	Clean Cont	LSCS	NG										
56	Kanagamani	47	Female	Surgery	Diaphragmatic hernia	1	3	Elective	Clean	Hernia repa	NG										
57	Mayavan	27	Male	Surgery	Small bowel obstruction with perforative peritonitis	0	11	Emergency	Dirty	Emergency	Acinetobac	S	S	S				S		S	
58	Palaniyappan	65	Male	Surgery	Acute intestinal obstuction	0	10	Emergency	Contamina	Emergency	Klebsiella o	S	S	S	S		S	S		S	
59	Murugan	43	Male	Surgery	Periampullary carcinoma	3	15	Elective	Clean Cont	Whipples p	E.coli	S	S				S	S		S	
60	Senthil	41	Male	Surgery	Ileal perforaton with mesenteric tear	0	11	Emergency	Dirty	Laparotom	Klebsiella	S	S					S		S	
61	Balakrishnan	43	Male	Surgery	ileal perforaton with peritonitis	0	14	Emergency	Dirty	Laparotom	Klebsiella	S	S					S		S	
62	Nagaraj	56	Male	Surgery	Acute intestinal obstruction with Perforation peritonitis	0	13	Emergency	Dirty	Laparotom	Klebsiella	S	S					S		S	
63	Krishnaveni	55	Female	Surgery	Ca breast	6	10	Elective	Clean	Mastectom	Staph aureus			S							DO E LZ VAN
64	Palaniyappan	70	Male	Surgery	Acute intestinal obstuction	0	9	Emergency	Contamina	Laparotom	Klebsiella o	S	S	S			S	S		S	
65	Mercy	24	Female	OG	Primi with fetal distress	0	4	Emergency	Clean Cont	LSCS	NG				S						
66	Priya	27	Female	OG	Primi with PIH	2	3	Elective	Clean Cont	LSCS	NG										
67	Sulochana	30	Female	OG	G2P1L1A0 with previous LSCS	3	4	Elective	Clean Cont	LSCS	Staph aureus			S							DO E LZ VAN
68	Kamalam	65	Female	OG	Cervical fibroid	2	4	Elective	Clean Cont	TAH with B	NG										
69	Dhanalakshmi	43	Female	Surgery	Cholelithiasis with appendicitis	0	6	Emergency	Clean Cont	Appendice	Staph aure	S						S			LZ VAN
70	Rajmohan	25	Male	Surgery	Appendicitis	0	6	Emergency	Clean Cont	Appendice	Klebsiella o	S	S					S		S	
71	Ammasai	45	Male	Surgery	Ileal perforation with peritonitis	0	16	Emergency	Dirty	Laparotom	Klebsiella p	S	S					S		S	
72	Sakthivel	29	Male	Surgery	Appendicitis	0	6	Emergency	Clean Cont	Appendice	Proteus mirabilis			S	S			S		S	
73	Kannan	36	Male	Surgery	TAO	3	17	Elective	Clean	Lumbar syr	CoNs	S									DO E LZ VAN
74	Siva	23	Male	Surgery	Appendicitis	0	4	Emergency	Clean Cont	Appendice	NG										
75	Kasiyammal	70	Female	Surgery	Strangulated incisional hernia	0	21	Emergency	Clean Cont	Laparotom	Staph aure	S		S		S			S		LZ VAN
76	Palaniyammal	62	Female	Surgery	Ca colon	2	22	Elective	Clean Cont	Hemicolect	Staph aure	S		S		S			S		LZ VAN
77	Vanathi	29	Female	OG	Primi with breech	0	4	Emergency	Clean Cont	LSCS	Staph aure	S		S		S			S		LZ VAN
78	Angel	23	Female	OG	Primi with fetal distress	0	4	Emergency	Clean Cont	LSCS	Pseudomo	S	S	S	S			S		S	CAZ TOB PIT MRP
79	Manimegalai	35	Female	OG	G2P1L1A0 with previous LSCS	2	4	Elective	Clean Cont	LSCS	NG										
80	Samy	45	Male	Orthopaed	Fracture rt tibia	2	13	Elective	Contamina	Ext fixation	Klebsiella pneumonia			S	S	S		S	S	S	
81	Prabhu	31	Male	Surgery	Ruptured splenic abscess with peritonitis	0	18	Emergency	Dirty	Laparotom	Klebsiella pneumonia			S	S	S	S	S	S	S	
82	Anandkumar	30	Male	Surgery	Perforated peritonitis	0	15	Emergency	Dirty	Emergency	Klebsiella pneumonia			S	S	S	S	S	S		
83	Surila	31	Female	OG	G2P1L1A0 with previous LSCS	2	4	Elective	Clean Cont	LSCS	Klebsiella p	S	S		S			S		S	
84	Maragathamani	35	Female	OG	G2P1L1A0 with previous LSCS	2	4	Elective	Clean Cont	LSCS	NG										
85	Prakash	31	Male	Surgery	Appendicitis	0	4	Emergency	Clean Cont	appendice	NG										
86	Balaiyan	53	Male	Surgery	SCC of Gluteal regionElective	3	17	Elective	Clean	Wide excis	Staph aure	S							S		
87	Thangaraj	49	Male	Orthopaed	Fracture shaft of lt humerus	3	5	Elective	Contamina	ORIF	Staph aure	S							S		DO ELZ VAN
88	Marimuthu	35	Male	Surgery	Incisional hernia	1	3	Elective	Clean	Hernia repa	NG										
89	Deivanai	52	Female	Surgery	Large bowel obstruction	0	5	Emergency	Clean Cont	Laparotom	E.coli, Pseu	S	S	S	S					S	
90	Sangeetha	26	Female	OG	Primi with failedinduction	0	4	Emergency	Clean Cont	LSCS	NG										
91	Murugeshwari	25	Female	OG	Primi with PIH	2	4	Elective	Clean Cont	LSCS	NG										
92	Kamarudeen	37	Male	Orthopaed	RTA crush injury	0	9	Emergency	Contamina	BK Amputa	Klebsiella p	S	S					S		S	
93	Mandhiri	55	Male	Orthopaed	Degloving injury from lt foot to calf	0	7	Emergency	Contamina	Wound del	pseudomo	S	S	S				S			TOB CAZ
94	Kuppusamy	45	Male	Orthopaed	Fracture both bone rt leg	3	5	Elective	Contamina	Bone curet	Klebsiella p	S	S	S				S		S	

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95	Jayabal	60	Male	Orthopaed	Compound fracture of lt leg	0	5	Emergency	Contamina	Wound deb	Klebsiella p	S	S	S							
96	Gunasekaran	20	Male	Orthopaed	Fracture lt tibia with raw area	0	5	Emergency	Contamina	Wound deb	staph aure	S				S					LZ VAN
97	Dhanalakshmi	22	Female	OG	Primi with PIH	1	4	Elective	Clean Cont	LSCS	Pseudomo	S		S				S		S	
98	Marimuthu	35	Male	Surgery	Hernia	1	3	Elective	Clean	Hernia repa	NG										
99	Thangamani	33	Female	Orthopaed	Malignancy of rt femur	7	19	Elective	Clean	Amputatio	E.coli	S	S					S		S	
100	Mylal	45	Female	Surgery	Strangulated femoral hernia with ileal gangrene	0	16	Emergency	Contamina	Laparotom	E.coli, Staph aure	S						S		S	
101	Ganapathy	42	Male	Orthopaed	Lt elbow dislocation with lt condylar fracture	0	5	Emergency	Contamina	ORIF with k	NG										
102	Krishnaveni	31	Female	OG	G2 P1 L1 A0 with previous LSCS	2	4	Elective	Clean Cont	LSCS	NG										
103	Mythili	25	Female	OG	G2 P1 L1 A0 with previous LSCS	2	4	Elective	Clean Cont	LSCS	Staph aure	S		S					S		DO E LZ VAN
104	Sumathi	25	Female	OG	primi with failed induction	0	4	Emergency	Clean Cont	LSCS	Staph aureus			S							DO E LZ VAN
105	Devaraj	29	Male	Orthopaed	Fracture lt tibia	2	5	Elective	Contamina	ORIF	Pseudomo	S		S				S		S	
106	Sundaram	53	Male	Orthopaed	fracture both bone rt leg	3	10	Elective	Contamina	External fx	staph aureus										DO LZ VAN
107	Narayanasamy	55	Male	Orthopaed	Fracture shaft of femur	0	5	Emergency	Contamina	ORIF	staph aure	S				S					LZ VAN
108	Kuppusamy	45	Male	Orthopaed	fracture both bone rt leg	3	5	Elective	Contamina	External fix	staph aure	S								S	DO LZ VAN
109	Rajalakshmi	48	Female	Surgery	Obstructive inguinal hernia	0	4	Emergency	Contamina	Hernia repa	Anaerobic bacilli										
110	Padmavathy	23	Female	OG	Primi with post dated	2	5	Elective	Clean Cont	LSCS	Staph aureus			S	S						DO LZ VAN
111	Raman	39	Male	Surgery	Duodenal ulcer perforation	0	8	Emergency	Dirty	Emergency	Staph aure	S		S	S		S		S		LZ VAN
112	Jeyaraman	48	Male	Orthopaed	RTA with fracture lt tibia	3	5	Elective	Contamina	Bone curet	klebsiella o	S		S	S		S		S		
113	Baskar	40	Male	Orthopaed	Fracture both bone rt leg	3	5	Elective	Contamina	ORIF	klebsiella pneumoniae						S		S		
114	Vimala	41	Female	Orthopaed	Fracture both bone lt leg	3	4	Elective	Contamina	ORIF	Staph aure	S				S					DO LZ E VAN
115	Muniyan	55	Male	Orthopaed	RTA Crush injury	0	16	Emergency	Contamina	Bkamputat	Pseudomo	S		S							TOB PIT
116	Muthusamy	44	Male	Orthopaed	Fracture both bone lt leg	3	5	Elective	Contamina	ORIF	Pseudomo	S		S							TOB PIT
117	Suganthi	55	Female	Surgery	Strangulated hernia	0	18	Emergency	Contamina	Hernia repa	Anaerobic bacilli										
118	Lakshmanan	13	Male	Surgery	Acute appendicitis	0	4	Emergency	Clean Cont	Appendice	NG										
119	Soundarya	20	Female	OG	Primi with fetal distress	0	4	Emergency	Clean Cont	LSCS	NG										
120	Ammasai	40	Male	Orthopaed	Fracture both bone rt leg	4	17	Elective	Contamina	ORIF	Pseudomonas aerugi			S				S	S		
121	Senthilkumar	35	Male	Surgery	Acute intestinal obstruction	0	5	Emergency	Contamina	Emergency	Pseudomonas aerugi			S					S	S	
122	Palanisamy	43	Male	Orthopaed	RTA with crush injury of lt leg	0	17	Emergency	Contamina	Soft tissue	Staph aureus					S			S		DO E LZ VAN
123	Muthusamy	75	Male	Orthopaed	Fracture both bone lt leg	4	5	Elective	Contamina	ORIF	Staph aureus			S				S		S	
124	Karuppasamy	50	Male	Orthopaed	Fracture both bone rt leg	4	5	Elective	Contamina	ORIF	Staph aureus			S				S		S	
125	Jeyaraman	48	Male	Orthopaed	RTA with compound fracture both bone lt leg	0	5	Emergency	Contamina	ORIF	Proteus mi	S	S	S	S			S	S	S	
126	Arumugam	66	Male	Orthopaed	Compound fracture of both bone lt leg	0	14	Emergency	Contamina	ORIF	Pseudomo	S	S	S	S			S	S	S	
127	Palanisamy	45	Male	Surgery	Inguinal hernia	3	5	Elective	Clean	Hernia repa	NG										
128	Ananthi	15	Female	Surgery	Acute appendicitis	0	5	Emergency	Clean Cont	Appendice	Staph aureus			S	S				S	S	
129	Lokeshwaran	67	Male	Orthopaed	Fracture tibia rt leg	5	5	Elective	Contamina	ORIF	Klebsiella p	S	S	S	S	S	S	S		S	
130	Balamurugan	30	Male	Orthopaed	RTA with fracture both bone rt leg	5	5	Elective	Contamina	ORIF	Pseudomonas aerugi			S	S						TOB CAZ MRP
131	Balaiyan	53	Male	Surgery	Acute intestinal obstruction	0	16	Emergency	Contamina	Emergency	Enterococci, Klebsiel			S				S	S	S	
132	Bharathi	24	Female	OG	Primi with CPD	1	4	Elective	Clean	LSCS	NG										
133	Ruthramani	75	Male	Orthopaed	Fracture tibia rt leg	4	5	Elective	Contamina	ORIF	Klebsiella p	S		S	S		S		S	S	
134	Mayilsamy	50	Male	Orthopaed	RTA with fracture of rt tibia	4	5	Elective	Contamina	ORIF	staph aureus			S	S			S	S		
135	Mohanraj	18	Male	Orthopaed	Fracture tibia rt leg	4	10	Elective	Contamina	Closed red	Klebsiella p	S		S	S				S	S	
136	Sindhu	12	Female	Orthopaed	Fracture ulnar	0	5	Emergency	Contamina	Closed red	NG										
137	Rajendran	42	Male	Surgery	Hydrocele	1	12	Elective	Clean	Excision of	Staph aure	S				S			S		
138	Dharmaraj	23	Male	Surgery	Ileal perforation	0	12	Emergency	Dirty	Laparotom	klebsiella p	S		S	S			S		S	
139	Prabhu	35	Male	Orthopaed	Lt sided communited fracture of tibia and fibula	0	5	Emergency	Contamina	Surgical de	klebsiella p	S		S	S			S		S	
140	Maragathamani	42	Male	Orthopaed	RTA with fracture both bone rt leg	3	5	Elective	Contamina	ORIF	Pseudomo	S	S	S			S	S		S	
141	Nagaraj	56	Male	Surgery	Large bowel obstruction	0	16	Emergency	Contamina	Laparotom	E.coli	S	S	S				S	S	S	

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142	Raman	55	Male	Orthopaed	RTA with crush injury of rt leg	0	5	Emergency	Contamina	BK amputa	Staph aure	S		S	S	S	S				DO E LZ VAN
143	Balamurugan	30	Male	Orthopaed	Fracture both bone rt leg	3	15	Elective	Contamina	wound deb	Klebsiella p	S		S	S				S	S	
144	Arrayi	50	Female	Orthopaed	Fracture femur	3	5	Elective	Contamina	ORIF	NG										
145	Palani	71	Male	Orthopaed	RTA with fracture both bone lt leg	3	5	Elective	Contamina	Wound deb	Staph aure	S							S		LZ VAN
146	Pappathy	35	Female	Surgery	Incisional hernia	1	5	Elective	Clean	Hernia repa	NG										
147	Muralidharan	45	Male	Orthopaed	Fracture both bone lt leg	4	12	Elective	Contamina	External fix	Pseudomonas aeruginosa, Klebsiella pneumoniae										
148	Rukmani	51	Female	Orthopaed	Fracture shaft of femur	0	5	Emergency	Contamina	Closed red	Staph aure	S		S		S			S		LZ VAN
149	Subramani kittar	30	Male	Orthopaed	Fracture both bone rt leg	3	5	Elective	Contamina	ORIF	Pseudomo	S	S	S	S						TOB PIT MRP
150	Ravichandran	45	Male	Orthopaed	RTA with crush injury of rt leg	0	5	Emergency	Contamina	BK amputa	NG										
151	Saraswathy	60	Female	Surgery	Duodenal ulcer perforation	0	18	Emergency	Dirty	Perforation	Anaerobic bacilli										
152	Rangasamy	76	Male	Orthopaed	Fracture tibia lt leg	5	5	Elective	Contamina	Closed red	Staph aure	S	S	S		S			S		LZ VAN
153	Rangaraj	55	Male	Orthopaed	Fracture tibia lt leg	5	5	Elective	Contamina	Closed red	NG										
154	Parathal	50	Female	Orthopaed	Comound fracture rt leg	0	5	Emergency	Contamina	Bone curet	Staph aure	S	S	S							DO E LZ VAN
155	Mareeswari	41	Female	Surgery	Duodenal ulcer perforation	0	21	Emergency	Dirty	Perforation	Staph aure	S	S	S							DO E LZ VAN
156	Gnanambal	50	Female	Surgery	Acute appendicitis	0	5	Emergency	Clean Cont	Appendice	NG										
157	Janaki	70	Female	Orthopaed	Fracture femur rt side	3	5	Elective	Contamina	ORIF	Pseudomonas aerugi	S							S		
158	Devi	27	Female	OG	G2 P1 L1 A0 with previous LSCS	3	5	Elective	Clean Cont	LSCS	NG										
159	Ramathal	38	Female	OG	G2 P1 L1 A0 with previous LSCS	1	5	Elective	Clean Cont	LSCS	NG										
160	Balamurugan	39	Male	Orthopaed	RTA with fracture of rt tibia	3	5	Elective	Contamina	Bone curet	E.coli	S	S						S		
161	gynanaprakash	24	Male	Orthopaed	Compound fracture of both bone lt leg	0	5	Emergency	Contamina	Surgical de	Klebsiella pneumonia	S		S					S		
162	Ramasamy	70	Male	Orthopaed	Distal fracture rt radius	0	5	Emergency	Contamina	External fix	NG										
163	Maheswari	26	Female	OG	Primi with Fetal distress	0	5	Emergency	Clean Cont	LSCS	CoNs	S							S		LZ VAN
164	Sundaraj	39	Male	Orthopaed	Rt tibial fracture	4	5	Elective	Contamina	Internal fix	Klebsiella pneumonia	S							S		
165	Periasamy	55	Male	Orthopaed	Fracture shaft lt tibia	4	5	Elective	Contamina	ORIF with I	Klebsiella pneumonia	S							S		
166	Muruganandhan	46	Male	Orthopaed	Fracture both bone rt leg	5	5	Elective	Contamina	ORIF	Klebsiella p	S	S	S							
167	Anandkumar	65	Male	Orthopaed	RTA with crush injury of rt leg	0	18	Emergency	Contamina	ORIF	Klebsiella pneumoniae								S		
168	Govindhan	40	Male	Orthopaed	Lt humerus fracture	0	5	Emergency	Contamina	Closed red	NG										
169	Subramani	35	Male	Surgery	Acute intestinal obstruction	0	5	Emergency	Contamina	Laparotom	E.coli	S							S		
170	Shanthamani	35	Male	Orthopaed	fracture shaft rt humerus	5	5	Elective	Contamina	ORIF	NG										
171	Murugesan	35	Male	Orthopaed	RTA with crush injury rt leg	0	14	Emergency	Contamina	AK amputa	E.coli, Proteus mirabilis				S				S		
172	Anbarasan	26	Male	Orthopaed	Compound fracture both bone rt leg	0	6	Emergency	Contamina	Bone curet	Staph aureus										LZ VAN
173	Mariyappan	37	Male	Orthopaed	Compound fracture both bone rt leg	0	6	Emergency	Contamina	Bone curet	Staph aureus										LZ VAN
174	Palani	70	Male	Orthopaed	Fracture rt tibia	3	6	Elective	Contamina	External fix	Staph aureus				S						LZ VAN
175	Peter	27	Male	Orthopaed	Compound fracture both bone rt leg	0	11	Emergency	Contamina	ORIF	Pseudomo	S	S	S		S					TOB PIT MRP
176	Murugesan	45	Male	Orthopaed	Bimalleolar fracture lt ankle	0	6	Emergency	Contamina	ORIF	Proteus mirabilis			S					S		
177	Ranganathan	50	Male	Surgery	Blunt injury abdomen with jejunal perforation	0	6	Emergency	Dirty	Resection a	Anaerobic bacilli										
178	Priya	26	Female	OG	G4 P1 L1 A2 with previous LSCS	6	6	Elective	Clean Cont	LSCS	Staph aureus			S		S					DO E LZ VAN
179	Ashikraja	17	Male	Orthopaed	Bimalleolar fracture rt ankle	0	5	Emergency	Contamina	ORIF	Proteus mirabilis								S		
180	Lakshmanan	21	Male	Orthopaed	Fracture shaft rt femur	0	5	Emergency	Dirty	External fix	Anaerobic cocci										
181	Gurusamy	64	Male	Orthopaed	Fracture rt patella	0	5	Emergency	Contamina	ORIF with T	CoNs	S		S							DO E LZ VAN
182	Sakthivel	45	Male	Orthopaed	RTA with crush injury of rt leg	0	16	Emergency	Contamina	ORIF	E.coli	S							S		
183	Mani	40	Female	Orthopaed	Fracture rt olecranon	0	5	Emergency	Contamina	ORIF	E.coli	S	S	S	S				S	S	
184	Rangammal	60	Female	Orthopaed	Fracture rt great toe 2nd and 3rd toe	0	5	Emergency	Contamina	internal fix	E.coli	S	S	S	S		S		S	S	
185	Subramani	70	Male	Orthopaed	Fracture neck rt femur	0	5	Emergency	Dirty	internal fix	Anaerobic bacilli										
186	Palanisamy	55	Male	Orthopaed	Fracture both bone lt leg	4	9	Elective	Contamina	Internal fix	Pseudomo	S		S	S						TOB PIT MRP
187	Abdul jabar	45	Male	Orthopaed	Fracture both bone rt leg	4	5	Elective	Contamina	External fix	NG										
188	Muralidharan	36	Male	Orthopaed	fracture lt tibia	4	5	Elective	Contamina	External fix	Proteus mirabilis			S	S						
189	Veerammal	71	Female	Orthopaed	Fracture shaft of humerus	0	8	Emergency	Contamina	External fix	Pseudomo	S	S	S					S		TOB PIT MRP
190	Surya	26	Male	Orthopaed	Fracture distal radius	0	5	Emergency	Contamina	External fix	NG										
191	Marimuthu	38	Male	Orthopaed	Fracture rt humerus	0	6	Emergency	Contamina	ORIF	NG										

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192	Dhandapani	36	Male	Orthopaed	fracture lt tibia	5	6	Elective	Contamina	ORIF	Staph aure	S	S	S				S		S	
193	Beenu	36	Male	Orthopaed	RTA with laceration of lower third of leg	0	6	Emergency	Contamina	Wound deb	NG										
194	Krishnan	75	Male	Orthopaed	supracondylar fracture lt femur	0	6	Emergency	Contamina	ORIF	NG										
195	Shajahan	55	Male	Orthopaed	Fracture rt olecranon	0	6	Emergency	Contamina	Screw fixat	NG										
196	Annapoorani	28	Female	OG	G3 P2 L2 A0 with previous LSCS	2	6	Elective	Clean Cont	LSCS	NG										
197	Maragatham	37	Female	OG	Fibroid uterus	2	6	Elective	Clean Cont	Total abdo	NG										
198	Kanimozhi	19	Female	OG	post dated with failed induction	2	6	Elective	Clean Cont	LSCS	Staph aureus			S		S			S		DO E LZ VAN
199	Nachimuthu	75	Male	Orthopaed	Distal radius fracture	0	6	Emergency	Contamina	External fix	NG										
200	Muthiah	40	Male	Orthopaed	Fracture both bone rt leg	5	6	Elective	Dirty	ORIF	Anaerobic cocci										
201	Gokilamani	21	Female	OG	Primi with post dated	2	6	Elective	Clean Cont	LSCS	NG										
202	Mohanraj	29	Male	Orthopaed	Lt middle 1/3 rd tibial fracture	4	6	Elective	Contamina	Closed redu	NG										
203	Lakshmanan	21	Male	Orthopaed	Fracture rt femur	0	6	Emergency	Contamina	ORIF	CoNs										DO E LZ VAN
204	Padmanaban	42	Male	Orthopaed	Fracture rt femur	0	6	Emergency	Contamina	ORIF	Psedomon	S	S	S	S	S	S	S	S	S	CAZ TOB PIT MRP
205	Gajendran	40	Male	Orthopaed	Fractur bimalleolar rt ankle	0	6	Emergency	Contamina	ORIF with T	Psedomon	S	S	S	S			S		S	
206	Parameswari	57	Male	Orthopaed	Fracture both bone rt leg	4	6	Elective	Contamina	ORIF	Klebsiella p	S	S	S	S		S	S			
207	Kalaivanan	20	Male	Orthopaed	Fracture lt tibia	4	6	Elective	Contamina	Closed redu	E.coli	S	S	S	S			S		S	
208	Selvi	28	Female	OG	G2 P1 L1 A0 with previous LSCS	1	6	Elective	Clean Cont	LSCS	NG										
209	Ramamoorthy	46	Male	Orthopaed	Fracture both bone lt leg	4	13	Elective	Contamina	Amputatio	E.coli	S	S	S	S			S		S	
210	Unniyammal	50	Female	Surgery	Appendicitis	0	6	Emergency	Clean Cont	Appendice	Klebsiella p	S	S	S	S		S		S		
211	Palanisamy	37	Male	Surgery	Acute intestinal obstruction	0	17	Emergency	Contamina	Colostomy	E.coli			S	S			S			
212	Ranganathan	26	Male	Surgery	Acute appendicitis	0	6	Emergency	Clean Cont	appendice	Staph aureus								S		DO E LZ VAN
213	Palaniyammal	55	Female	Surgery	Duodenal ulcer perforation	0	10	Emergency	Dirty	Laparotom	E.coli, Prot	S		S	S			S		S	
214	Rubini	24	Female	OG	Primi with transverse lie in labour	0	6	Emergency	Clean Cont	LSCS	NG										
215	Annapoorani	24	Female	OG	Primi with fetal distress	0	6	Emergency	Clean Cont	LSCS	NG										
216	Rajmohan	46	Male	Orthopaed	Fracture rt tibia	2	7	Elective	Contamina	ORIF with l	Klebsiella o	S	S	S	S			S		S	
217	Selvi	28	Female	OG	G2 P1 L1 A0 with previous LSCS	1	6	Elective	Clean Cont	LSCS	NG										
218	Ramamoorthy	46	Male	Orthopaed	Fracture both bone lt leg	4	9	Elective	Contamina	BK disartic	E.coli										
219	Unniyammal	50	Female	Surgery	Appendicitis	0	6	Emergency	Clean Cont	Appendice	Klebsiella pneumoniae										
220	Palanisamy	37	Male	Surgery	Acute intestinal obstruction	0	10	Emergency	Contamina	Colostomy	E.coli										

KEY TO MASTER CHART

E.coli	- Escherichia coli
CONS	- Coagulase Negative Staphlococcus
MAC	- MacConkey agar
BAP	- Blood Agar Plate
M	- Male
F	- Female
OG	- Obstetric and Gynaecology
LSCS	- Lower Segment Cesarian Section
ORIF	- Open Reduction Internal Fixation
CREF	- Closed Reduction External Fixation
RTA	- Road Traffic Accident
PIH	- Pregnancy Induced Hypertension
CPD	- Cephalo Pelvic Disproportion
BK	- Below Knee Amputation
AIO	- Acute Intestinal Obstruction
AK	- Amikacin
G	- Gentamycin
COT	- Cotrimoxazole
AMC	- Amoxy clavulanic acid
CIP	- Ciprofloxacin
CTX	- Cefotaxime
CFS	- Cefoperazone sulbactum
AMP	- Ampicillin
PIT	- Piperacillin Tazobactum

OF	- Ofloxacin
DO	- Doxycycline
E	- Erythromycin
LZ	- Linezolid
VAN	- Vancomycin
NG	- No growth